Freak Waves in Nature: Facts, Theories and Modeling

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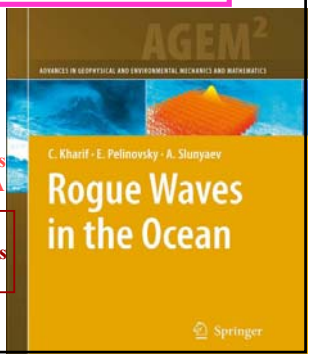
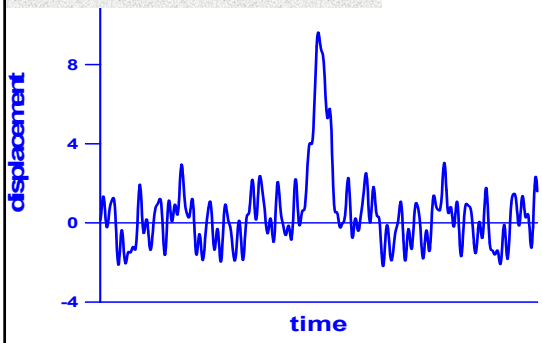


Int. Workshop
Mathematics of Extreme Sea Waves
June 13-16, 2011

Poseidon, shaker of the earth,
drove on a great wave,
that was terrible and rough,
and it curled over and broke down upon him,
and scatters it abroad in every direction

Homer "The Odyssey"

Freak Wave Definition



$$H_{freak} > 2\,H_{significant}$$

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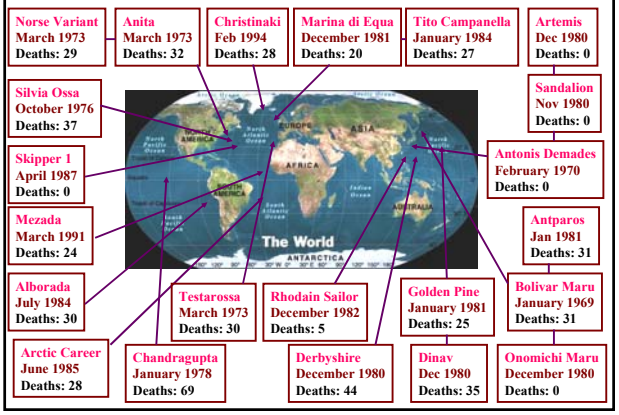
22 supercarriers were lost for 1968-1994 (Deaths:525)



Correlation to ship density

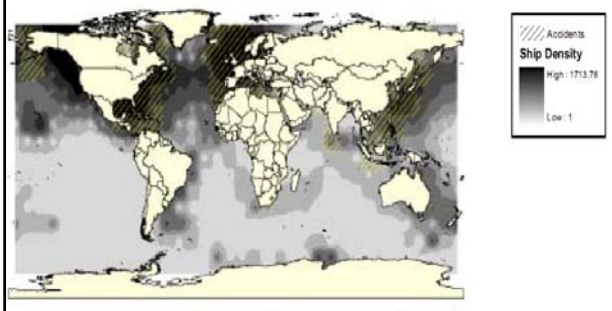


Figure 10: Global distribution of ship density and locations of accidents occurrence.

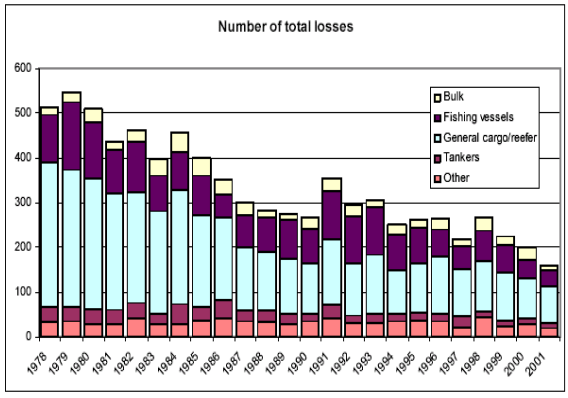


Figure 11 Decline in total losses from 1978 - 2001

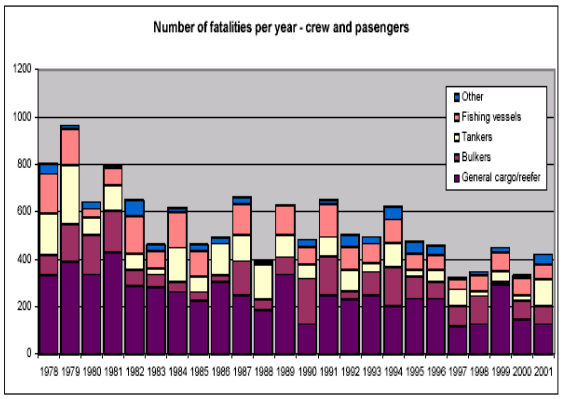
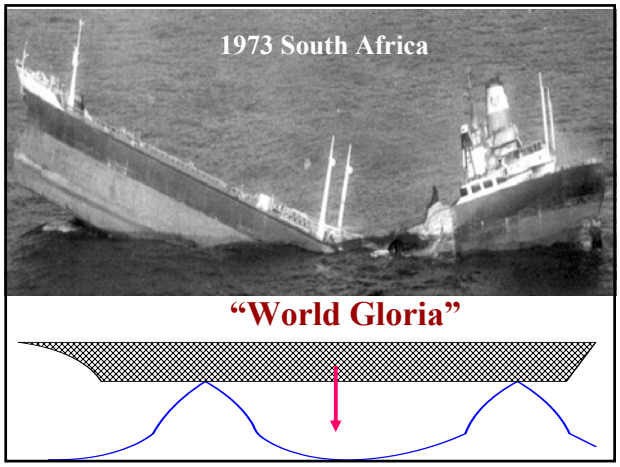
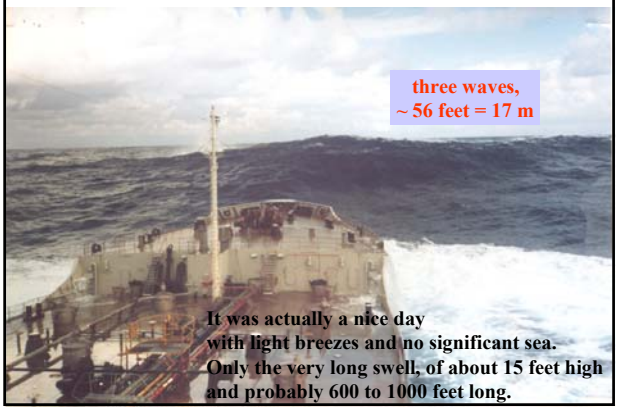


Figure 14 Number of fatalities due to accidents during the period 1978 - 2001



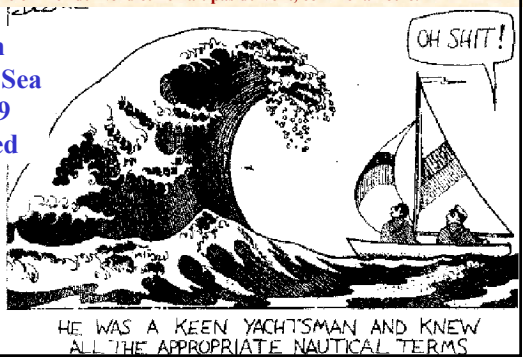
Gulf Stream, off of Charleston **February of 1986**

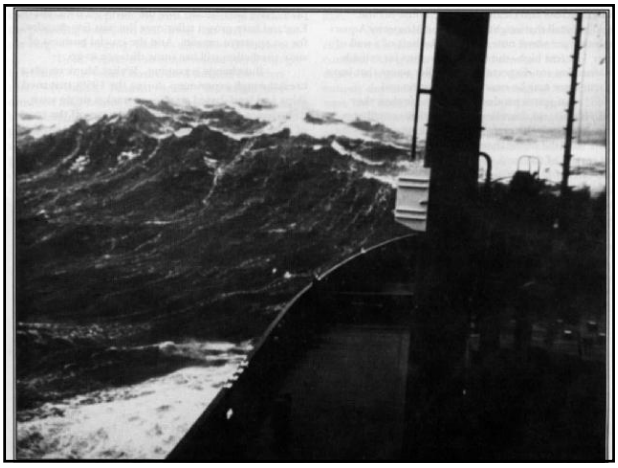


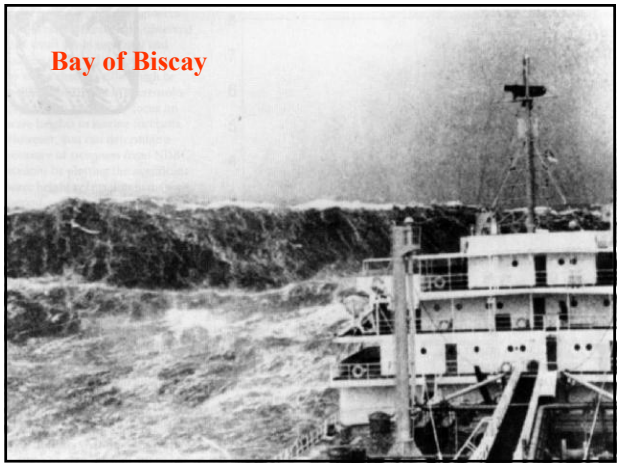
It was actually a nice day
with light breezes and no significant sea.
Only the very long swell, of about 15 feet high
and probably 600 to 1000 feet long.

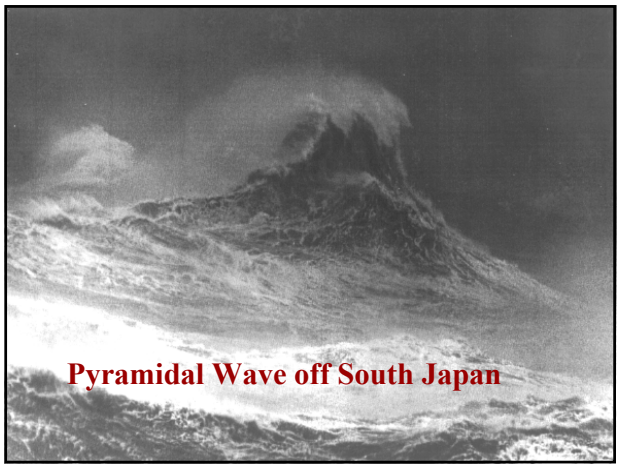
L`éré dernier, au large du port anglais de Harwich, John Sibley et Denis Hayman pèchent paisiblement. La mer est calme. Soudain, une vague de cinq mètres de haut surgit. Sibley périt, noyé. Depuis, Hayman provoque enquète sur enquète. La vérité sur cette vague extraordinaire vient d'être publiée. Parce que le phénomène n'est pas rare en mer du Nord et ne halt pas du vent, comme la houle.

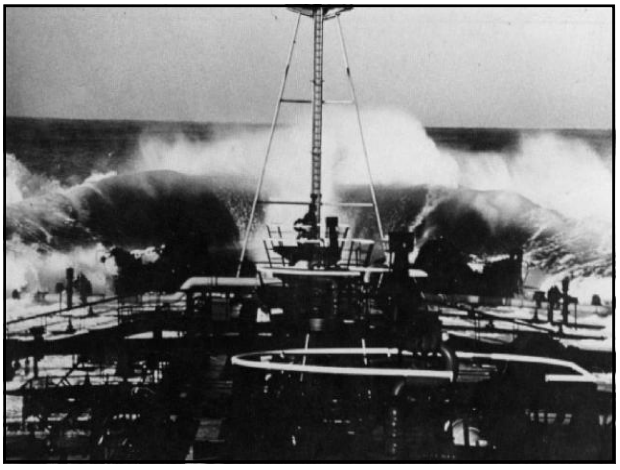
5 m
North Sea
1999
1 died



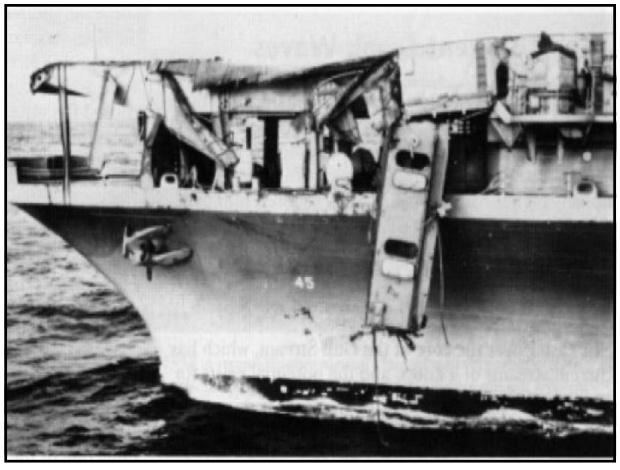


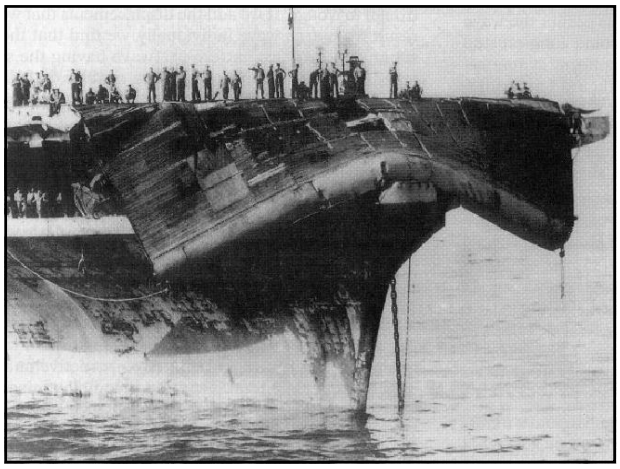



Pyramidal Wave off South Japan



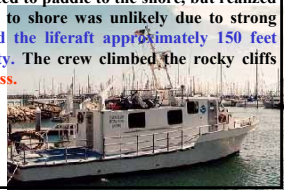
South Africa
WILSTAR





NOAA VESSEL SWAMPED BY ROGUE WAVE

At 4/11/2000, the 56-foot R/V Ballena capsized in a rogue wave south of Point Arguello, California. The Channel Islands National Marine Sanctuary's research vessel was engaged in a routine side-scan sonar survey for the U. S. Geological Survey of the seafloor along the 30-foot-depth contour approximately 1/4 nautical mile from the shore. The crew of the R/V Ballena consisted of the captain, LCdr. Pickett, research scientist Dr. Cochrane, and research assistant, Boyle. According to NOAA, the weather was good, with clear skies and glassy swells. The actual swell appeared to be 5-7 feet. At approximately 11:30 a.m., Pickett and Boyle said they observed a 15-foot swell begin to break 100 feet from the vessel. The wave crested and broke above the vessel, caught the Ballena broadside, and quickly overturned her. All crewmembers were able to escape the overturned vessel and deploy the vessel's liferaft. The crew attempted to paddle to the shore, but realized the possibility of navigating the raft safely to shore was unlikely due to strong near-shore currents. The crew abandoned the liferaft approximately 150 feet from shore and attempted to swim to safety. The crew climbed the rocky cliffs along the shore. The R/V Ballena is a total loss.

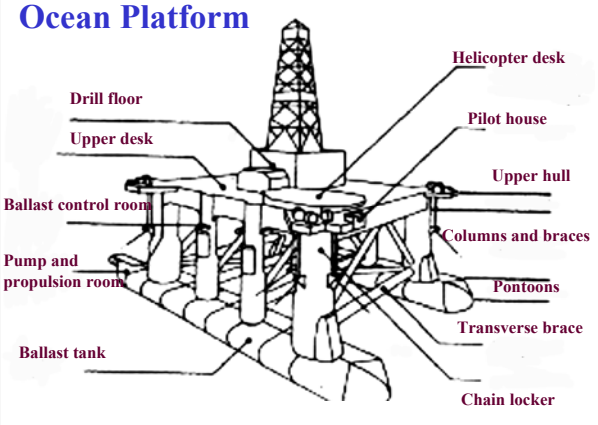


Significance for:

Oil and Gas Exploration

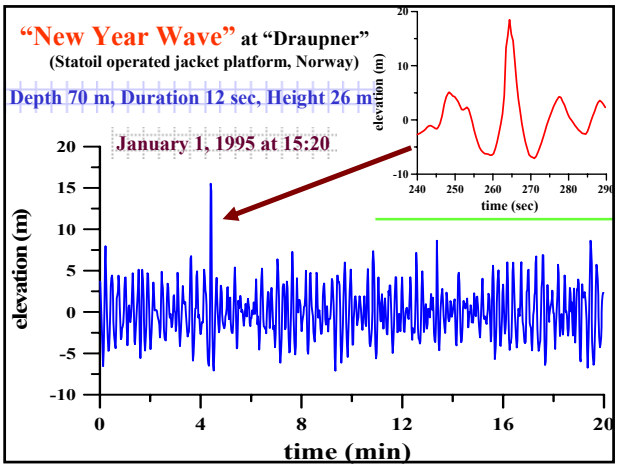
Offshore Engineering

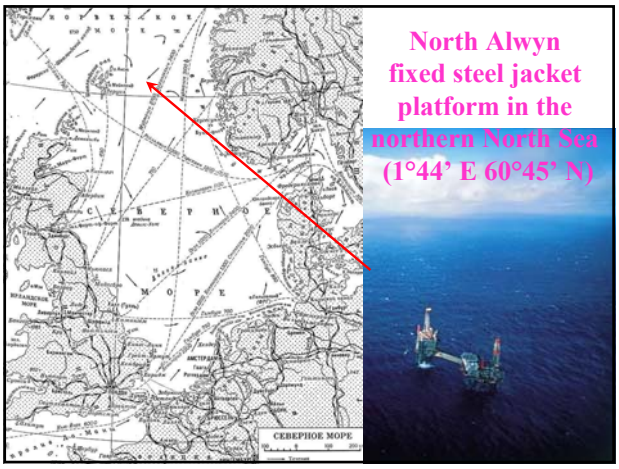
Ocean Platform

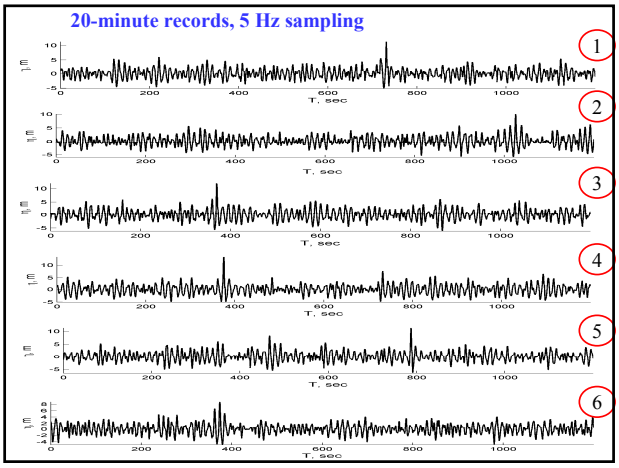


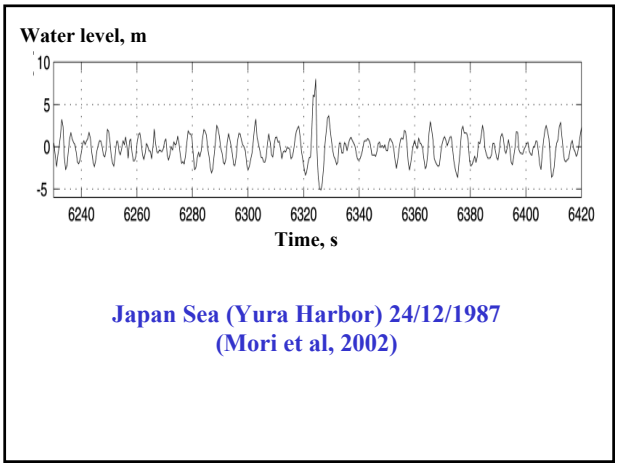
Instrumental Data

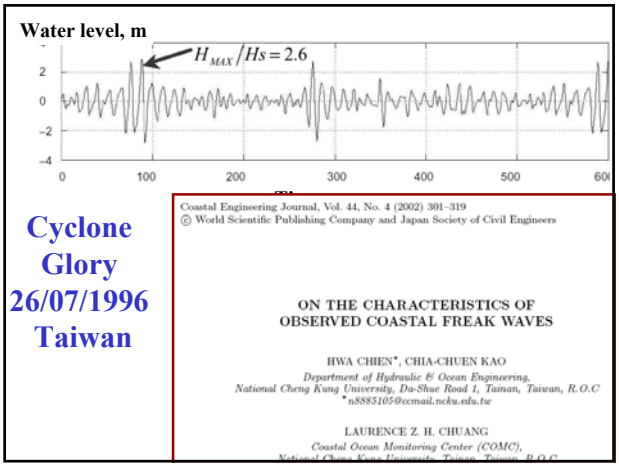
Location	Depth m	Height, m	Max Height, m	H_{max} / H_s	Registration	Year
Gork, Eire	20	5,0	12,8	2,6	Waverider	1969
Gulf of Mexico	100	10,4	19,4	1,9	Wave staff	1969
Gulf of Mexico	350	10,0	23,0	2,3	Wave staff	1969
Gorm Field, DK	40	6,8	17,8	2,6	Radar	1981
Gorm Field, DK	40	7,8	16,5	2,1	Radar	1981
Ekofisk, N	70		20 – 22	> 2,5	Damage	1984
Gorm Field	40	5,0	12,0	2,4	Radar	1984
Gorm Field	40	5,0	11,3	2,3	Radar	1984
Gorm Field	40	5,0	11,0	2,2	Radar	1984
Gorm Field	40	4,8	13,1	2,7	Radar	1984
Hanstholm, DK	20	2	6 – 7	3	Visual	1985
Hanstholm, DK	40	3,5	7,6	2,2	Waverider	1985


"New Year Wave" at "Draupner"
(Statoil operated jacket platform, Norway)
Depth 70 m, Duration 12 sec, Height 26 m
January 1, 1995 at 15:20
elevation (m)
time (min)
time (sec)


North Alwyn
fixed steel jacket
platform in the
northern North Sea
(1°44' E 60°45' N)
CEBEPHOE MOPE


20-minute records, 5 Hz sampling
1
2
3
4
5
6
T, sec


Water level, m
Time, s
Japan Sea (Yura Harbor) 24/12/1987
(Mori et al, 2002)


Water level, m
$H_{MAX}/Hs = 2.6$
Cyclone
Glory
26/07/1996
Taiwan
Coastal Engineering Journal, Vol. 44, No. 4 (2002) 301–319
© World Scientific Publishing Company and Japan Society of Civil Engineers
ON THE CHARACTERISTICS OF
OBSERVED COASTAL FREAK WAVES
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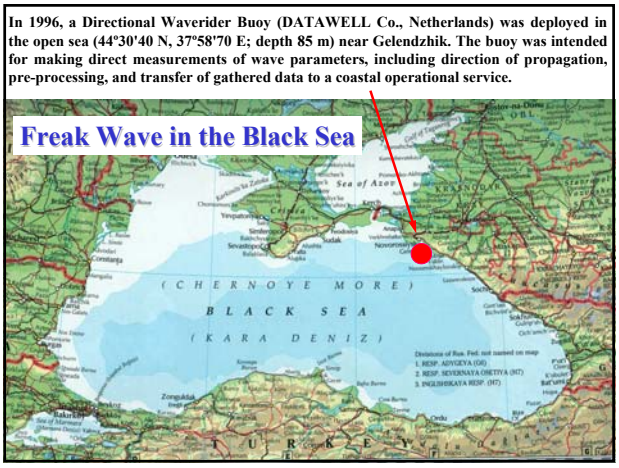
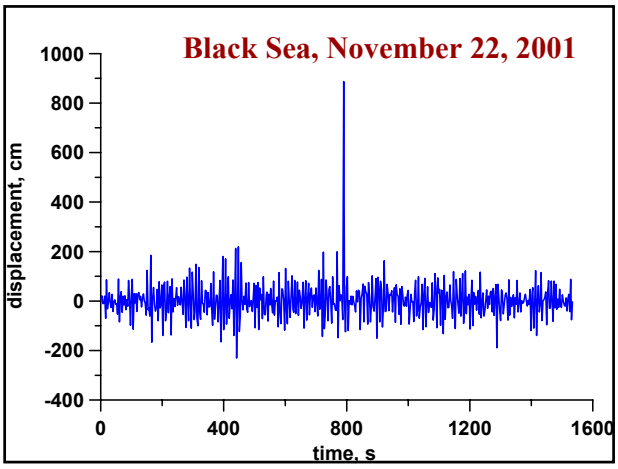
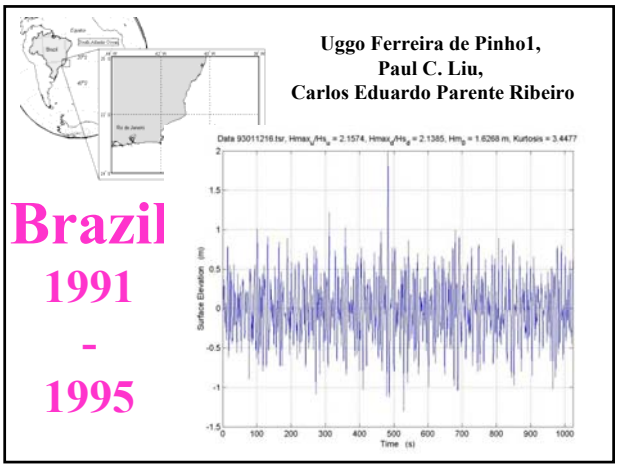
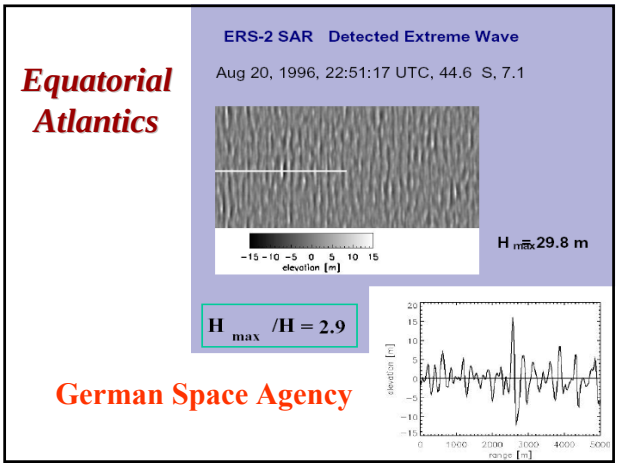
Coastal Ocean Monitoring Center (COMC),


In 1996, a Directional Waverider Buoy (DATAWELL Co., Netherlands) was deployed in the open sea (44°30'40 N, 37°58'70 E; depth 85 m) near Gelendzhik. The buoy was intended for making direct measurements of wave parameters, including direction of propagation, pre-processing, and transfer of gathered data to a coastal operational service.
Freak Wave in the Black Sea
(CHERNOYE MORE)
BLACK SEA
(KARA DENIZ)
TURKEY

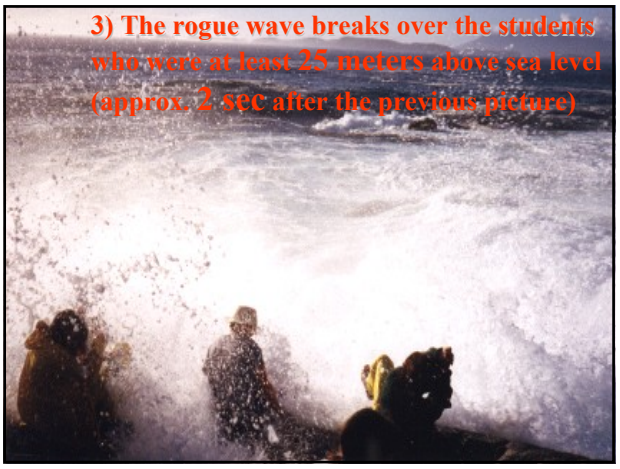






In October, 1998, thirteen students in the Bamfield Marine Station Fall Program were taken on a field trip to Kirby Point, a wave-beaten peninsula on the southwest corner of Dianna Is. (Barkley Sound, Vancouver Island, British Columbia), to view the large open-ocean swell breaking on the shore the day after a very large storm had passed through. The students split into two groups and sat atop two adjacent rock outcrops, at least 25 meters above sea level

After about 45 minutes of wave watching, one student tried to capture the feel of these huge waves thundering onto the shore by taking *three pictures* in quick succession of what looked to be a nice example of a large wave as it started to break



In these stormy seas, 45 minutes was not enough time to judge how high to stay on the shore to avoid being hit by a breaking wave. In the preceding 45 minutes, the next closest wave had only reached to within 5 m of the students

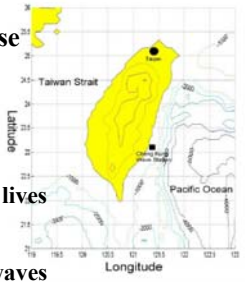
Almost every year people are killed by rogue waves on the west coast of Vancouver Island

Had any of these students been even a few meters lower on the shore, they might have been washed off

Historical "Rabid-Dog Waves" Data Base

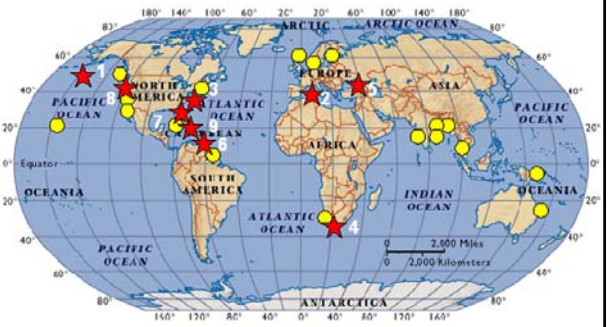
140 eyewitness reports from 1949 to 1999

More than 496 people lost their lives and more than 35 crafts were capsized due to nearshore freak waves



Taiwan (Chien et al, 2002)

Freak Waves in 2005-2006



Events selected as true freak waves are marked by red stars (1 – „Explorer", 2 – "Grand Voyager", 3 – "Norwegian Dawn", 4 – Kalk Bay, 5 – Blue Bay, 6 – Maracas Beach, 7 – Blake de Pastino, 8 – Port Orford, 9 – Petit Havre); yellow circles mark all other reported cases when abnormally large waves were observed

The 965-foot liner on way from Bahamas to New York was struck 16 April, 2005 by rogue 21 m wave

"My room was destroyed by stuff getting thrown all over the place."

"It was pure chaos."

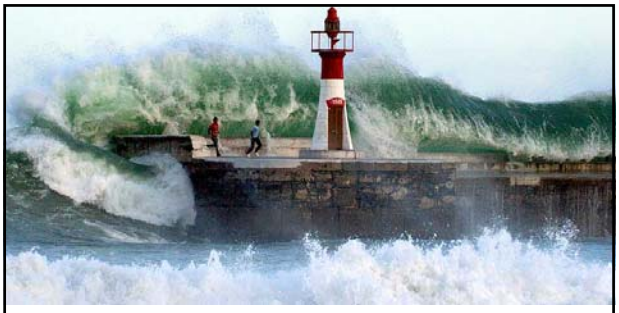
It weathered most of a wild storm that featured gale-force winds and choppy seas. But then the vessel, longer than three football fields, was suddenly smacked by the "freak wave. It broke a pair of windows and flooded 62 cabins."

"The sea had actually calmed down when the wave seemed to come out of thin air at daybreak."

"Our captain, who has 20 years on the job, said he never saw anything like it."

The tidal wave wrecked windows on the ninth and 10th floors and wreaked havoc below decks, destroying furniture, the onboard theatre, and a store that sold expensive gifts.

It also injured four passengers and terrified scores more, many of whom lost belongings and were being flown back to New York early this morning.



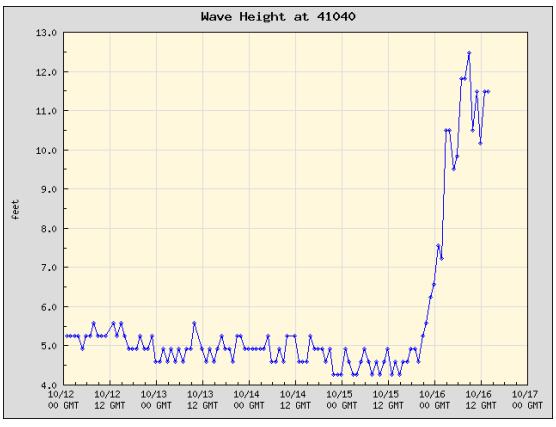
The wave over 9 m washed two people off the breakwater in Kalk Bay (South Africa) on August 26, 2005

16 October, 2005 Trinidad 8 m

16 October, 2005 Trinidad 8 m

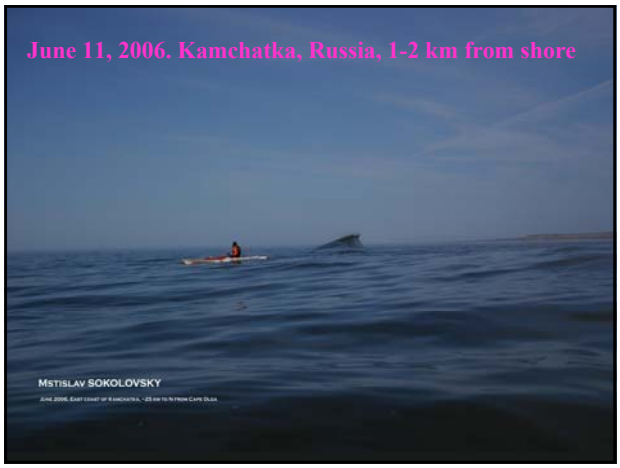
16 October, 2005 Trinidad 8 m

Jamaica, the same day



22 May 2006, English Channel, 12 m up to 6 desk

June 11, 2006. Kamchatka, Russia, 1-2 km from shore



View from Pacific

August 28, 2006

perthnow

Freak wave kills Japanese skipper

September 01, 2006 03:30pm

Article from: AAP

THE captain of a Japanese tuna fishing boat has been killed by a freak wave in international waters off the West Australian coast.

The 53-year-old captain and three crew members were thrown against the bulkhead of the 379 tonne tuna fishing boat, Hoshin Maru, when it was hit by a wave in the Southern Ocean.

The incident happened on Monday about 10pm WA police Sergeant Graham Clifford said.

`The boat was hit by a freak wave and a number of the fishermen including the captain were thrown against the bulkhead and he received injuries that caused his death," Sgt Clifford said.

The crew members received minor injuries, he said.

The boat has now docked in Fremantle and authorities are investigating, he said.

It is believed the captain's family have arrived in Perth.

A post-mortem examination will be carried out.

September 15, 2006 USA

Recovery Mission Called Off

POSTED: 5:45 am EDT September 15, 2006
UPDATED: 3:27 pm EDT September 15, 2006

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CAPE ELIZABETH, Maine -- The Maine Marine Patrol has called off its search for a missing lobsterman who disappeared Wednesday when his boat capsized after being hit by a rogue wave.

Video: Still No Sign Of Missing Lobsterman

The April Lee was struck by a rogue wave that might have been kicked up by the remnants of Hurricane Florence late Wednesday morning off McKenney Point, sending its crew into the waters of Seal Cove.

Charles Currier said he was hauling traps alongside the boat's owner, Steve Smith, 50, and his son when the wave hit.

September 22, 2006 Trinidad & Tobago

Trinidad & Tobago's Newsday The People's Newspaper

Home » News » Fisherman dies in freak accident

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Fisherman dies in freak accident

Friday, September 22 2006

A FREAK accident on a pirogue off the shores of Chatham beach resulted in the death of a 21-year-old fisherman yesterday morning.

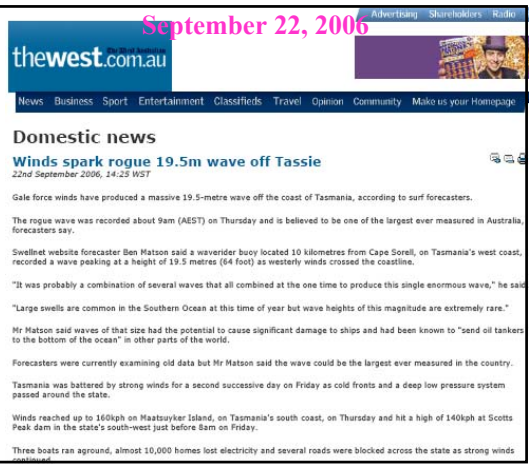
Police said around 6.30 am, fisherman Dinanath Ramrattan, 21, of Iros Foress Village was aboard a pirogue in company with another fisherman when he struck his head against the boat which was rocking violently after being buffeted by large waves.

As a dazed Ramrattan tried to keep his balance, another wave swept over the pirogue slamming him into the bow of the boat and he fell into the sea. His companion quickly pulled him from the water and rode the pirogue to shore.

An unconscious Ramrattan was taken to the Point Fortin District Hospital where he was pronounced dead on arrival. Insp Ramsey and Cpl Gangaram visited the scene and recorded a statement from the other fisherman.

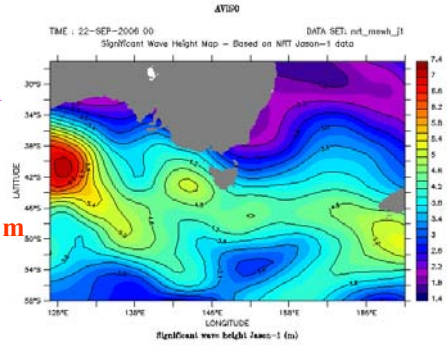
Constable Jack of Point Fortin CID is investigating.

September 22, 2006

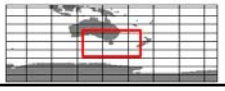


$H_s < 7$ m

$H_{max} = 19.5$ m



$H_{max}/H_s \sim 2.8$



September 25, 2006

North Wales, United Kingdom

Queenstown, South Africa

October 8, 2006

BRIT GIRL RIDER IS KILLED BY A WAVE
Oct 8 2006
By Nick Owens

A BRITISH tourist has been killed by a freak wave while horse riding in South Africa

Claire Jackson, 36, was washed out to sea and drowned after the huge 15ft wave crashed over her and two companions on a remote coast near Queenstown, in the Eastern Cape.

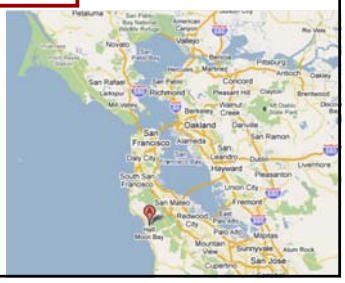
South Korea May 4, 2008

At least eight people are reported to have been killed after they were swept away by high waves.

Rogue Waves 2010 *February 14, 2010*

CNN producer note

sra3001 biked over to the Mavericks Surf Competiton in Half Moon Bay this morning and noticed some waves splashing over the sea wall. He backed up because he figured other waves would come over. He was right. He captured images of the giant wave surging over the sea wall and onlookers being knocked over.
- zdan, CNN iReport producer



March 2, 2010, Barcelona - Marseille

Louis Majesty

Courier Mail

Two dead as massive wave hits cruise ship Louis Majesty in Mediterranean

- From: *AP*
- March 04, 2010 8:43AM

A MASSIVE 8m-plus wave has smashed into a cruise ship carrying nearly 2000 people in the Mediterranean, smashing glass windshields and killing two passengers

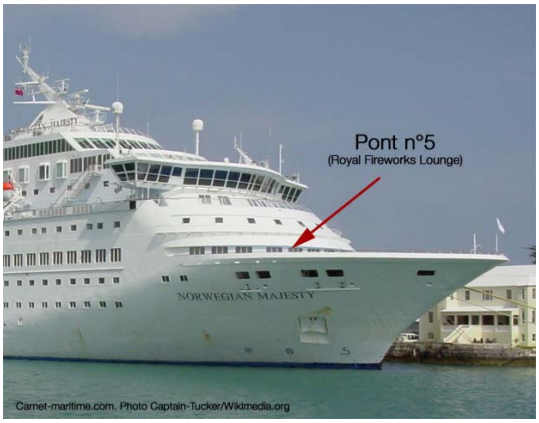
Another six people suffered light injuries, the Greek coast guard said in a statement. The victims were identified as a German and an Italian man.

The ship asked for permission to dock in Barcelona and arrived at the Spanish port shortly after 9 p.m.local time , the Spanish news agency Europa Press said.

There, four ambulances were waiting to take the bodies and the injured to a hospital in the city, the agency said.

No further details on the dead or the injured were immediately available. Spanish reports said the injured included a 62-year-old woman who broke both of her legs.

It was unclear late Wednesday exactly where the incident took place. The Greek coast guard said the accident occurred near the French Mediterranean port of Marseille as the Cypriot-owned Louis Majesty was sailing from Barcelona to the Italian city of Genoa with 1,350 passengers and 580 crew members on board.



The sea-state reported by the Cap Begur buoy, just next to the casuality at the time of the accident (14h15TU) was 5 m. It seems that the slightly change in the direction of 2nd wave just after the ship has plunged in the 1st trough of a bigger wave associated with a high steepness is responsible for the hurt . So, the Freak character of the event is rather related to the shape, the direction of the waves, the presence of several bigger waves, the position of the ship, than to the ratio of the maximum wave height (reported to 8m, but maybe a little more) versus the significant wave height (5m).

Meteo France

March 7, 2010 Norway

Her, like utenfor den islagte Karidammen skjeddde den fatale ulykken. Svabergene sprekker opp i en kløft i akkurat dette området.

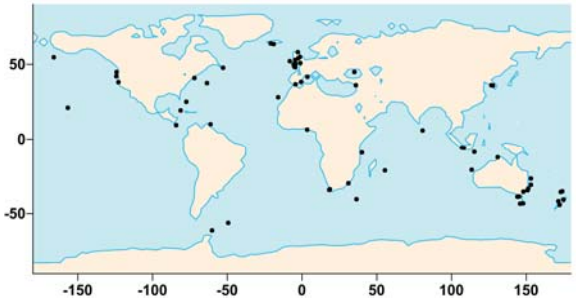
Thanks to Dr. Tomas Torsvik for reference

Two girls (9 years) were swept away by waves while they were playing at the coast. It's not clear how large the waves were, but it was windy on the coast.

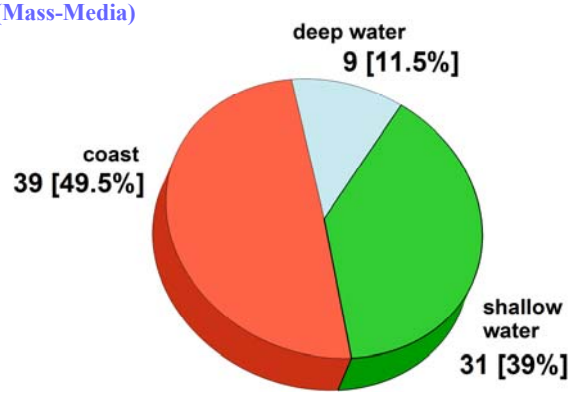
June 26, 2010 Cassis, France

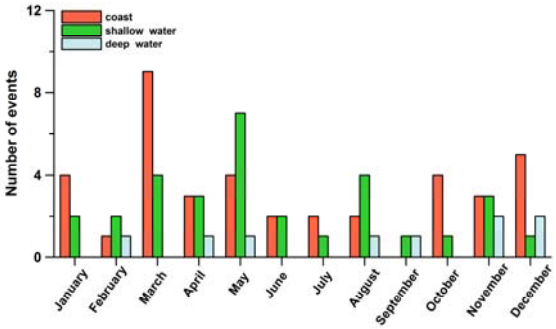
Four waves of height 50-80 cm climbed on beach on distance 8 m washed out many dresses. It occurred on small beach near the port of Cassis (on right). Sea was with no waves and clear water. After water was with sediment

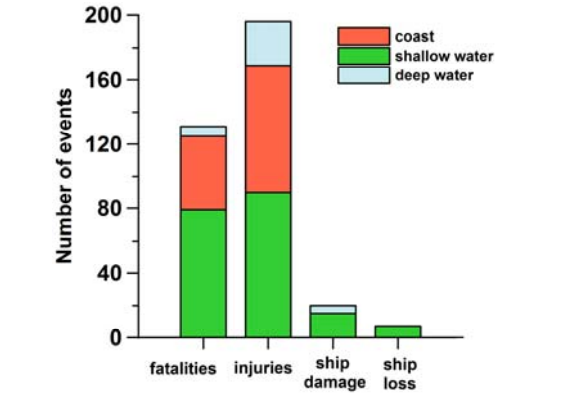
Rogue Waves in 2006-2010
(Nikolkina & Didenkulova, 2011)



(Mass-Media)

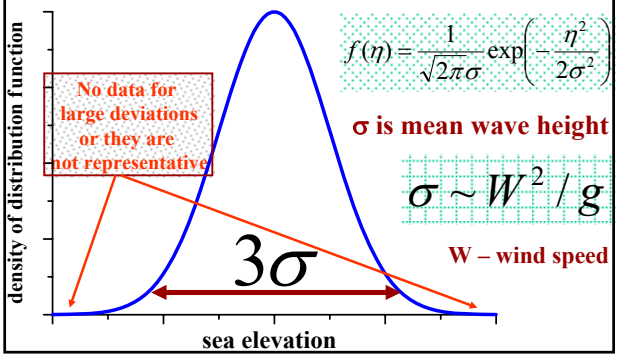






Why does large wave appear?

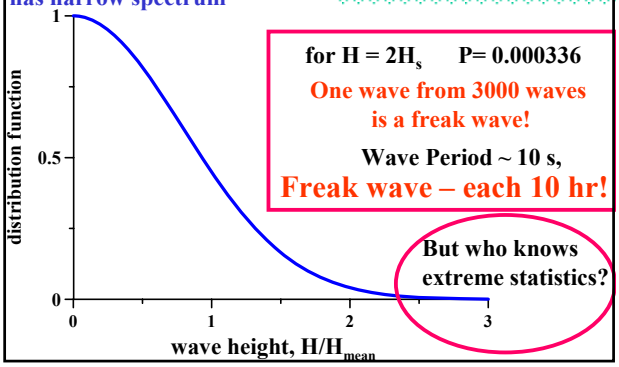
Wind wave field is quasi-Gaussian random process



"Gaussian" Prediction

Wind wave field has narrow spectrum

$$P(H) = \exp\left(-\frac{2H^2}{H_s^2}\right)$$



for $H = 2H_s$ P= 0.000336

One wave from 3000 waves is a freak wave!

Wave Period ~ 10 s,

Freak wave – each 10 hr!

But who knows extreme statistics?

Statistical approach:

- needs long-term time series (it is possible now)
- but always will be incorrect for extreme values of amplitudes (its level will increasing with duration of record)

Physical (Dynamical) approach:

-leads to find conditions when freak waves can appear

Mechanisms:

- Wave – current interaction
  - wave blocking,
  - random caustics.

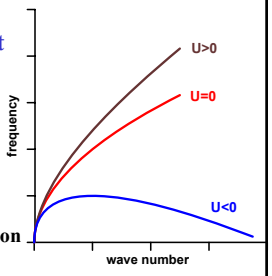
Wave – Current Interactions

❑ Blocking on opposite current

$$\omega = \sqrt{gk} + \vec{k}\vec{U}(x,y)$$

blocking at $c_{gr} = -U(x)$

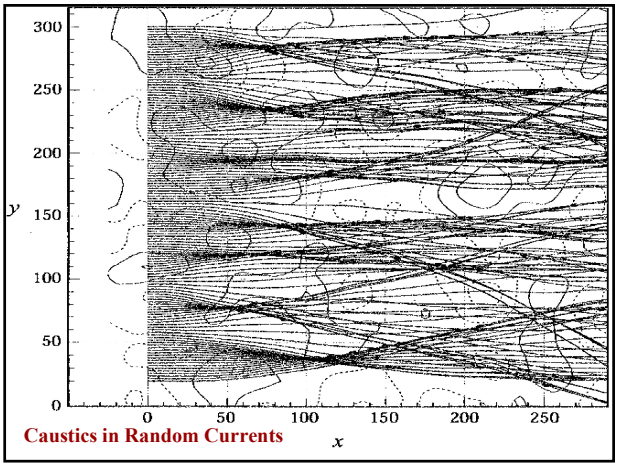
Models: energy balance equation, nonlinear Schrodinger equation



❑ Random Caustics

Wave – Current Interaction

Indian River Inlet, Delaware, USA



Caustics in Random Currents

Mechanisms:

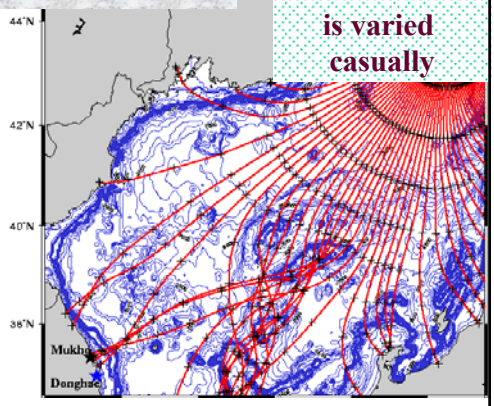
- **Wave – current interaction**
  - wave blocking,
  - random caustics.
- **Wave – bottom interaction**
  - focuses,
  - random caustics.

shallow water only

Wave Bottom Interactions

Wind direction is varied casually

Shallow Water only



Random Focuses, Caustics

Mechanisms:

- **Wave – current interaction**
  - wave blocking,
  - random caustics.
- **Wave – bottom interaction**
  - focuses,
  - random caustics.

shallow water only

- **"Itself" wave dynamics**
  - temporal-spatial focusing

Geometrical Focusing

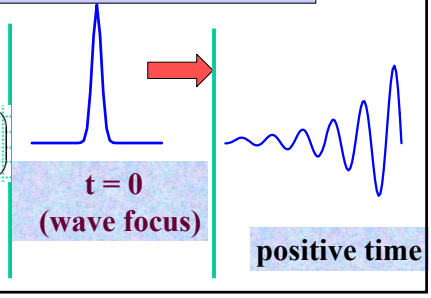
Dispersion Enhancement

Physics: *Phase speed is $c_{ph}(k)$*

Shallow-water

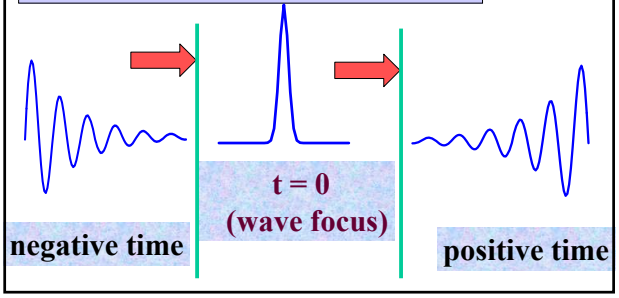
$$c_{ph}(k) = \sqrt{gh}\left(1 - \frac{k^2h^2}{6}\right)$$

Airy Function



Dispersion Enhancement

Physics: *Phase speed is c(k)*

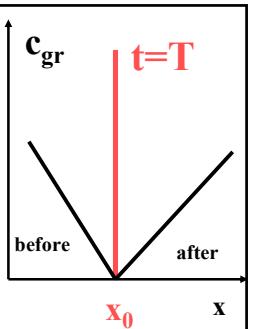


Kinematic Model

$$\frac{\partial \omega}{\partial t} + c_{gr}(\omega)\frac{\partial \omega}{\partial x} = 0$$

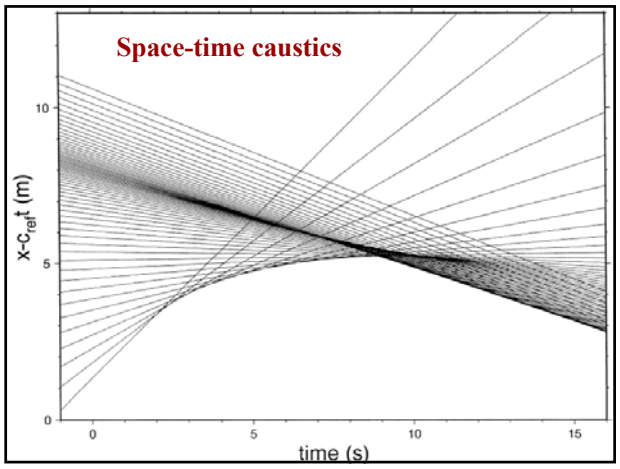
$$\frac{\partial c_{gr}}{\partial t} + c_{gr}\frac{\partial c_{gr}}{\partial x} = 0$$

$$c_{gr}(\omega) = \frac{x - x_0}{t - T}$$



collapse, focus

Increased wind



Who is responsible for frequency modulated wave Focused in the Freak Wave ?

Of course, **WIND**

But variable wind!

Waves are generated by resonant wind:

$$c_{ph}(k) \sim W$$

Light Wind generates Slow (Short) Waves,

Strong Wind generates Fast (Long) Waves.

And Long Waves overtake Short Waves (Focusing)

Kinematic Model: Amplitude

$$\frac{\partial c_{gr}}{\partial t} + c_{gr}\frac{\partial c_{gr}}{\partial x} = 0 \qquad \frac{\partial A^2}{\partial t} + \frac{\partial}{\partial x}\left(c_{gr}A^2\right) = 0$$

$$c_{gr}(x,t) = c_0(\xi) = c_0(x - c_{gr}t)$$

$$A(x,t) = \frac{A_0(\xi)}{\sqrt{1 + t(dc_0/d\xi)}}$$

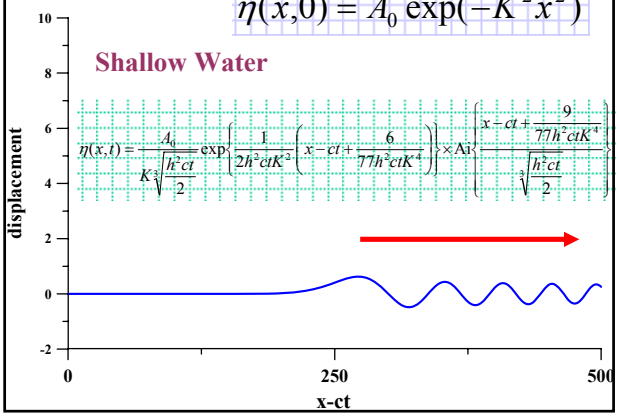
infinity in focus

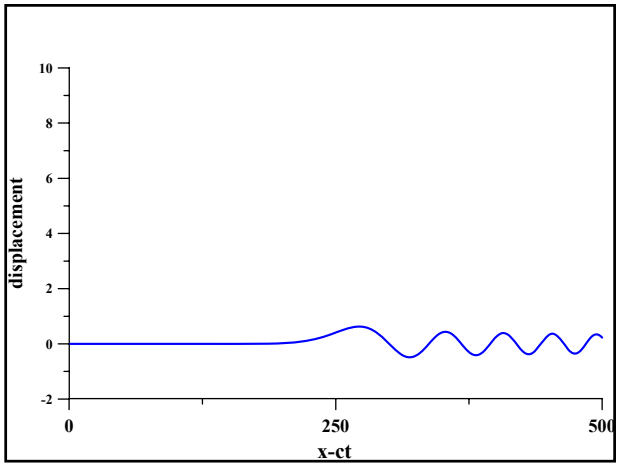
No valid in focus

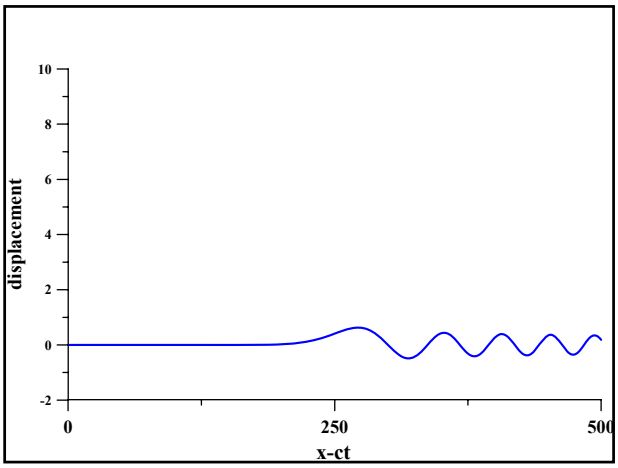
Analytical Test:

$$\eta(x,0) = A_0 \exp(-K^2 x^2)$$

Shallow Water



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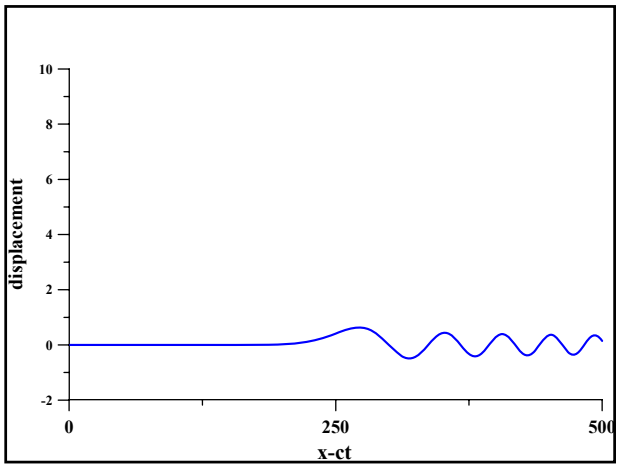
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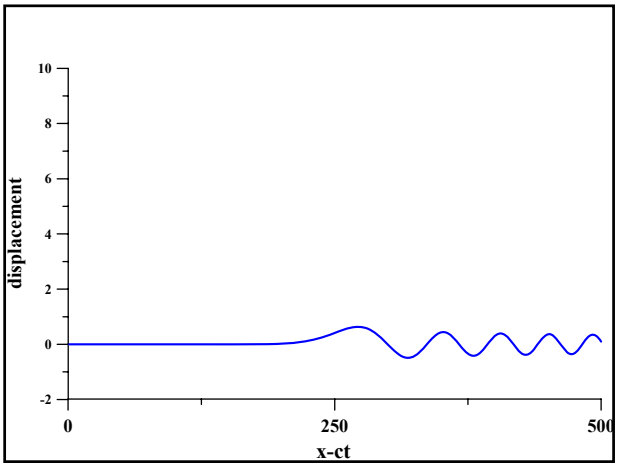
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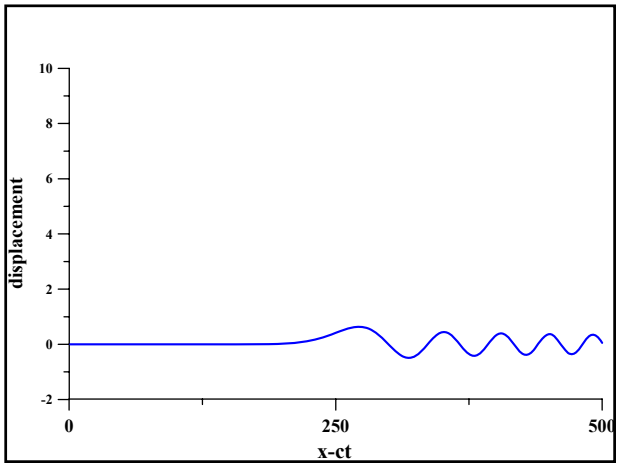
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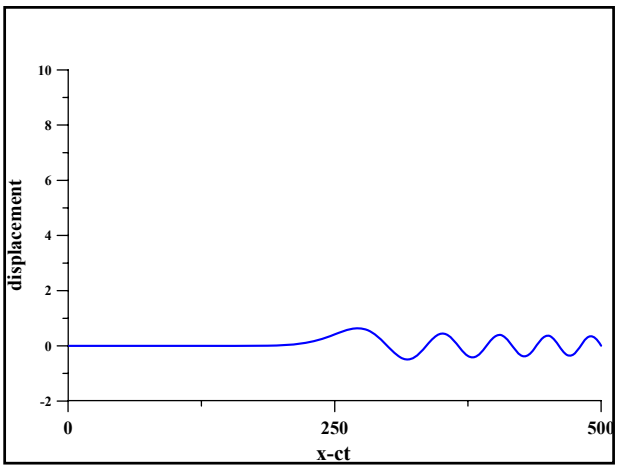
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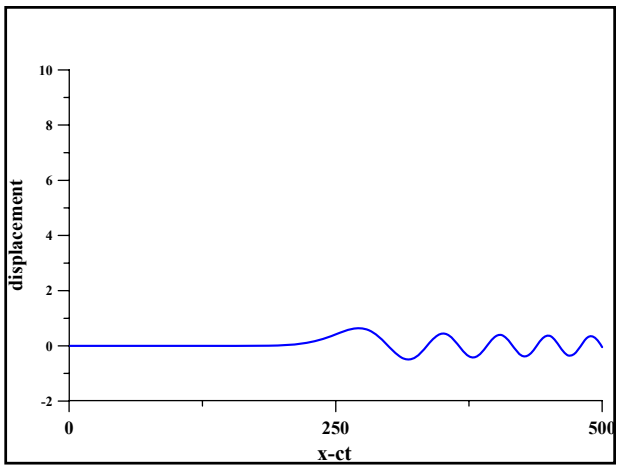
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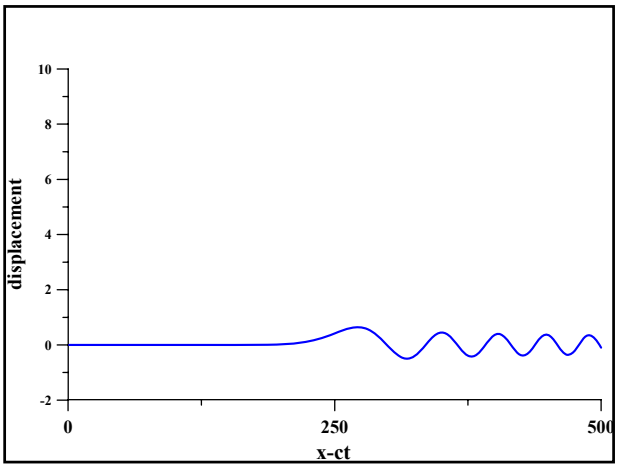
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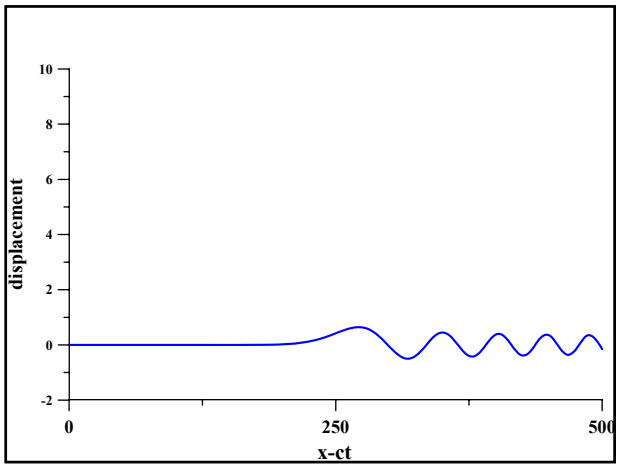
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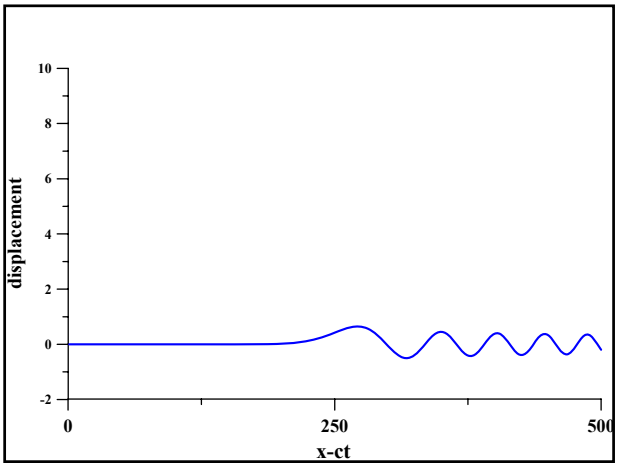
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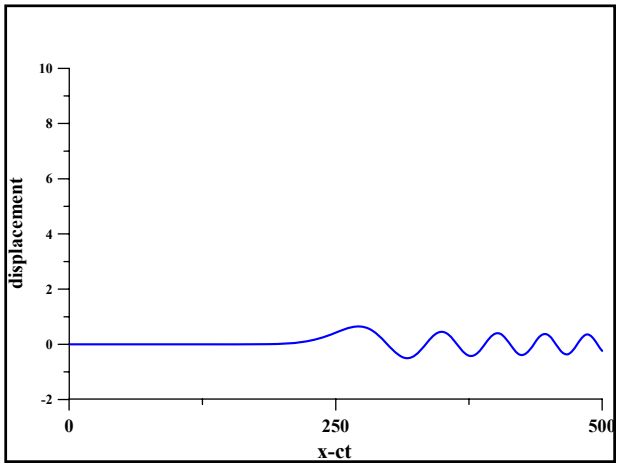
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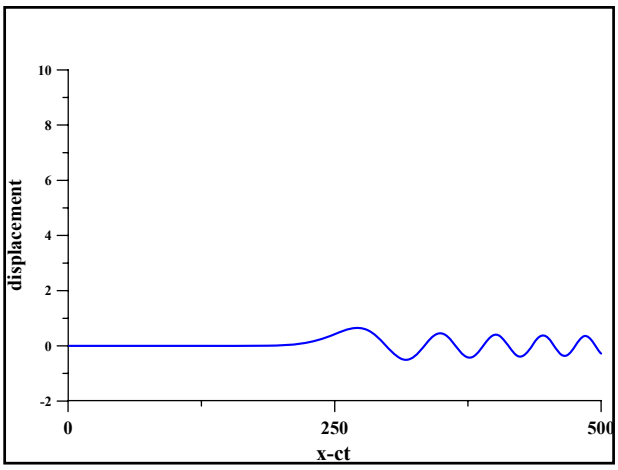
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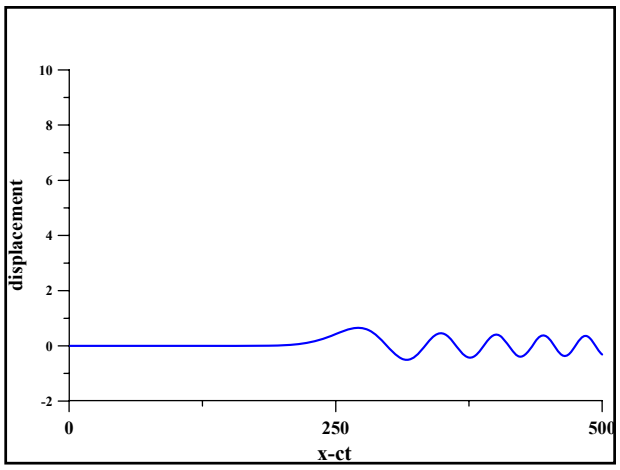
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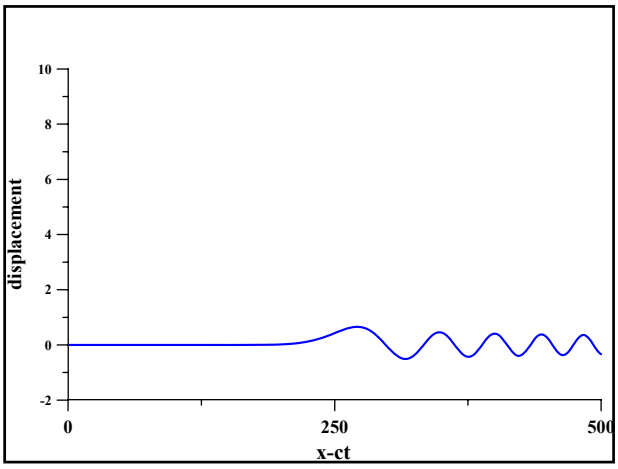
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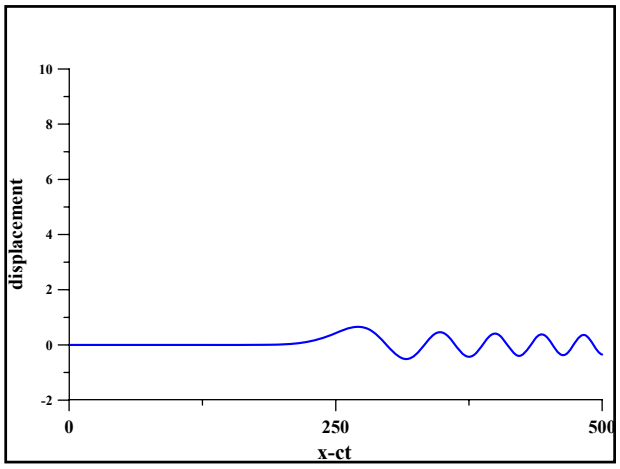
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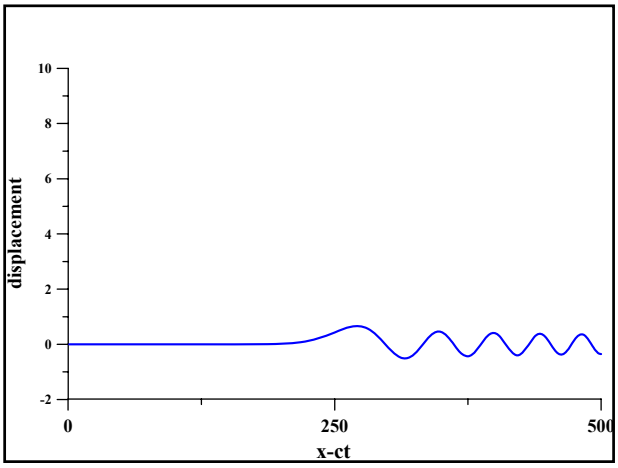
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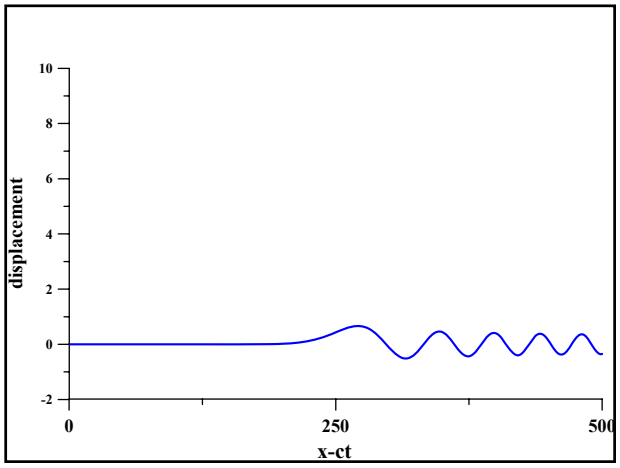
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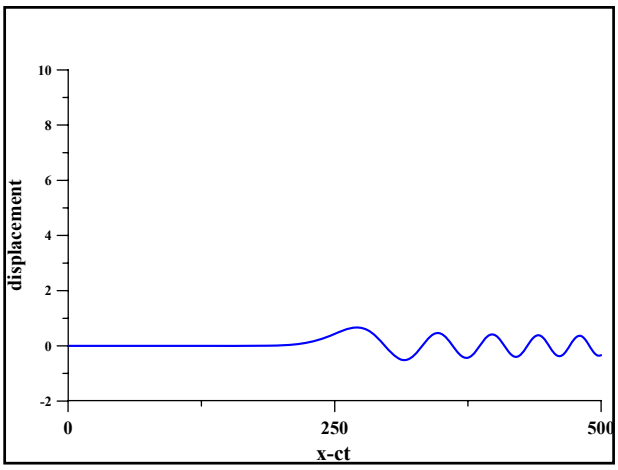
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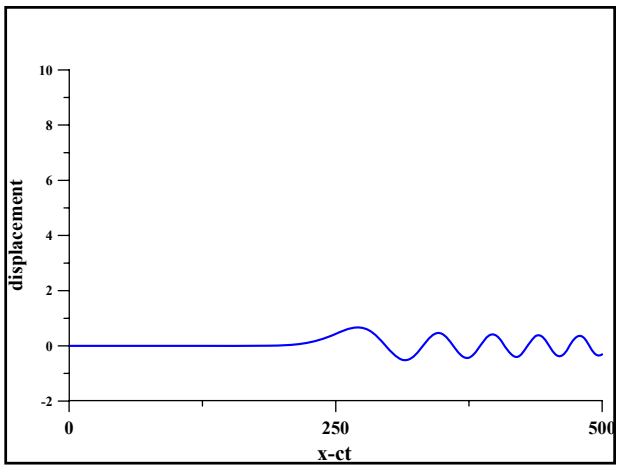
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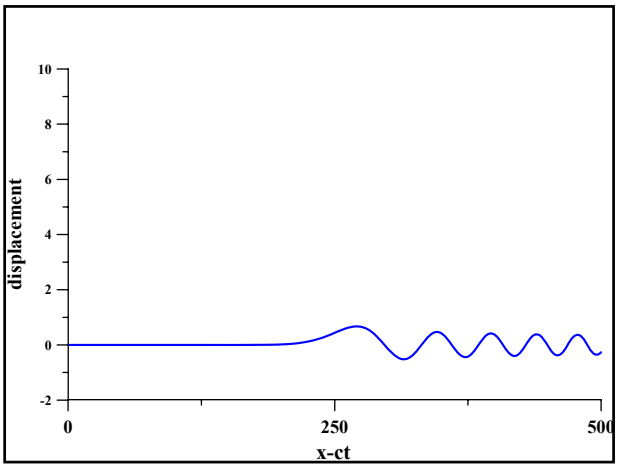
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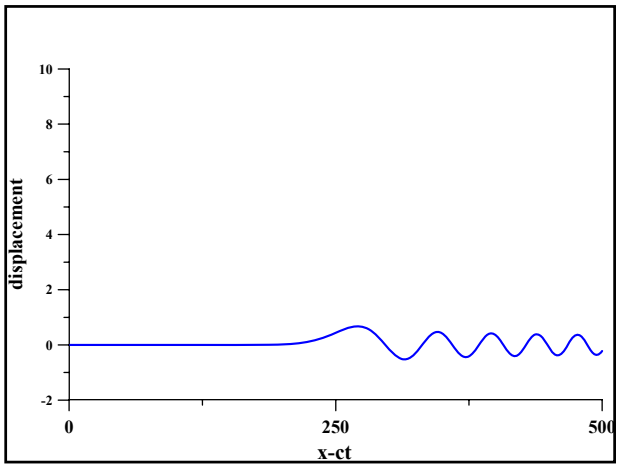
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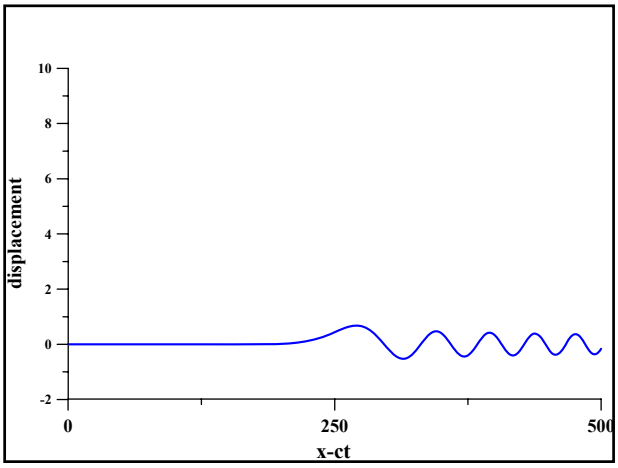
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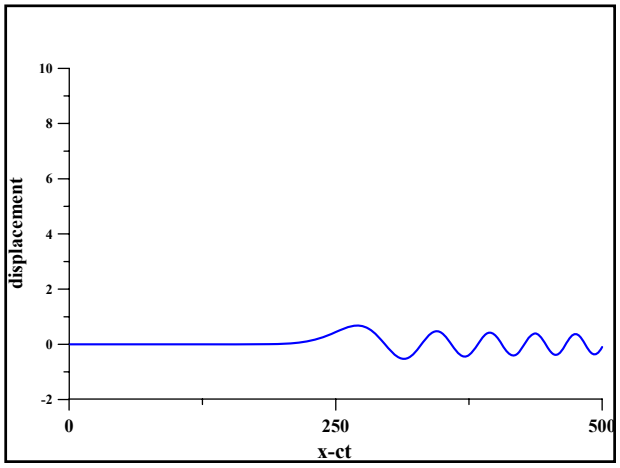
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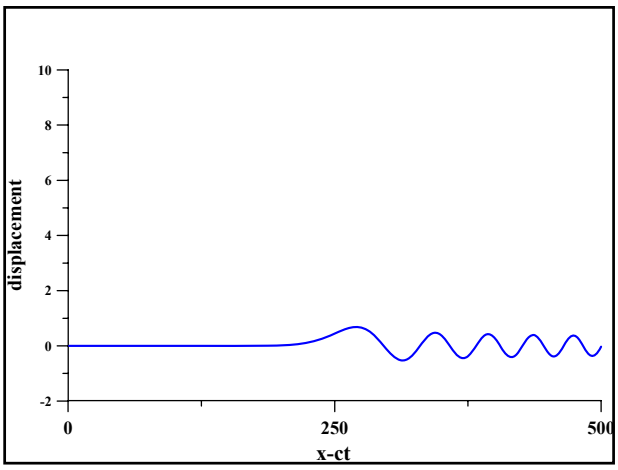
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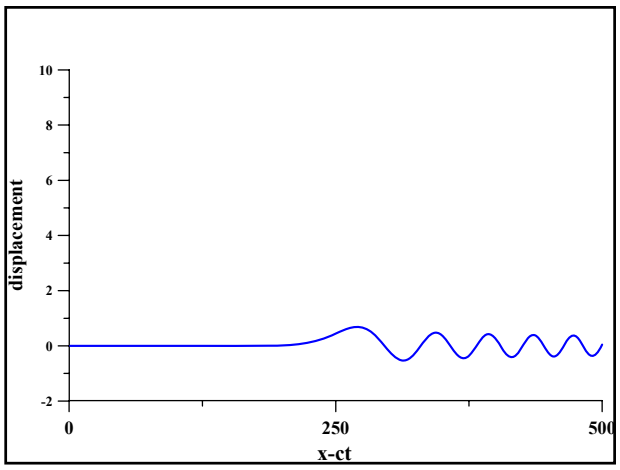
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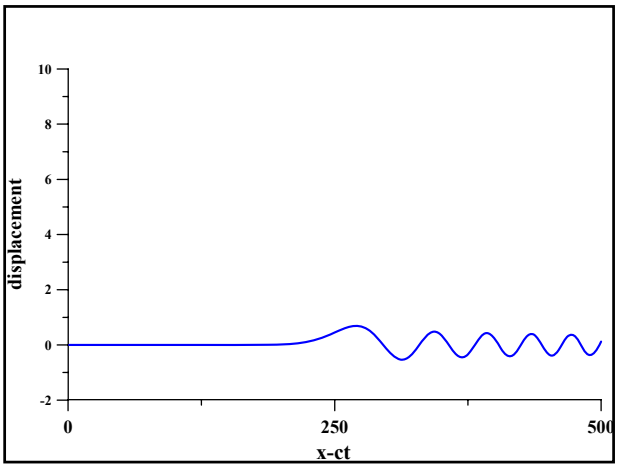
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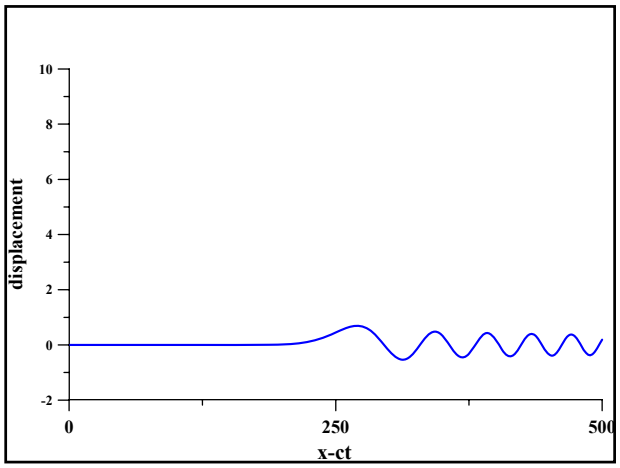
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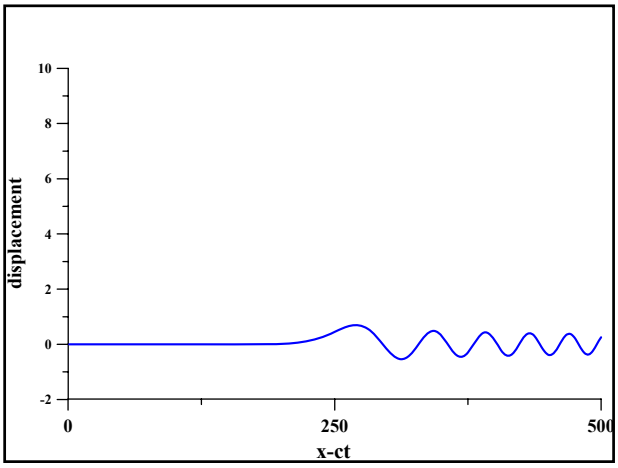
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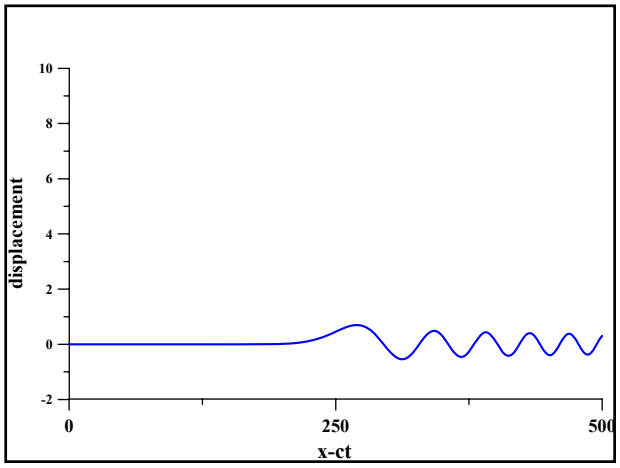
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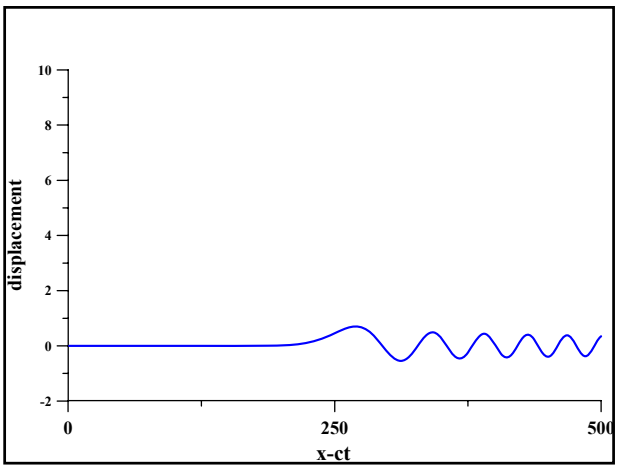
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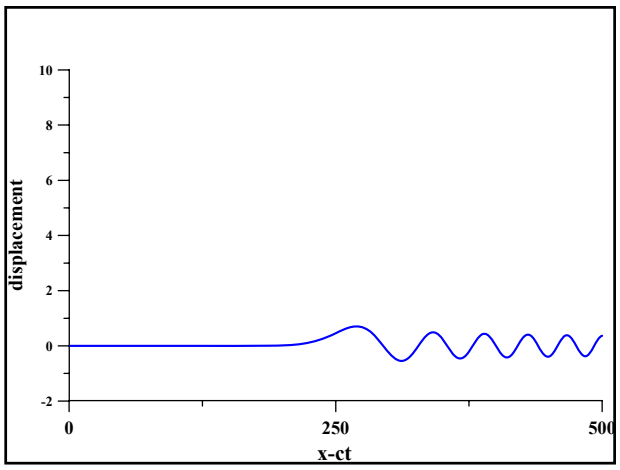
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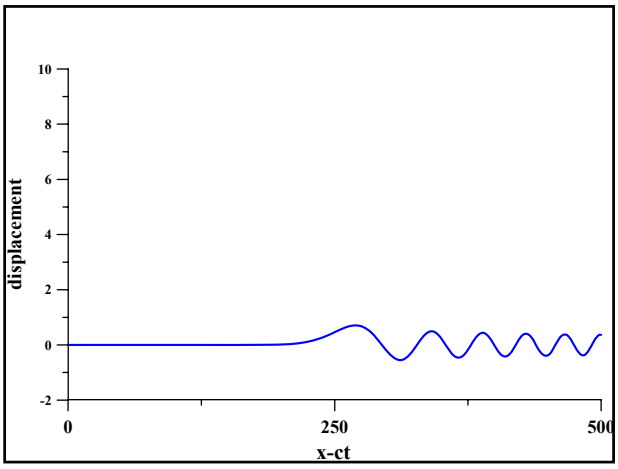
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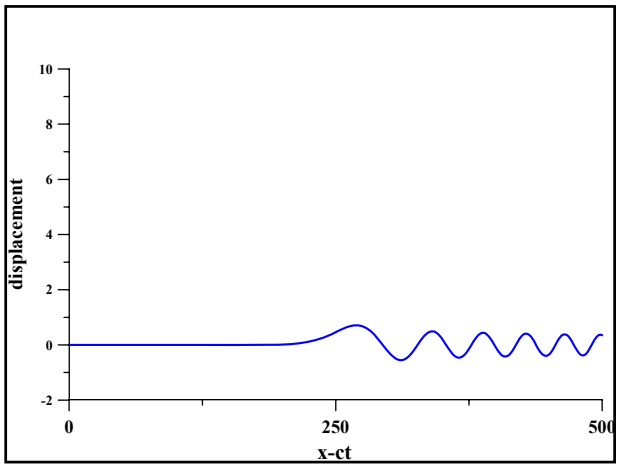
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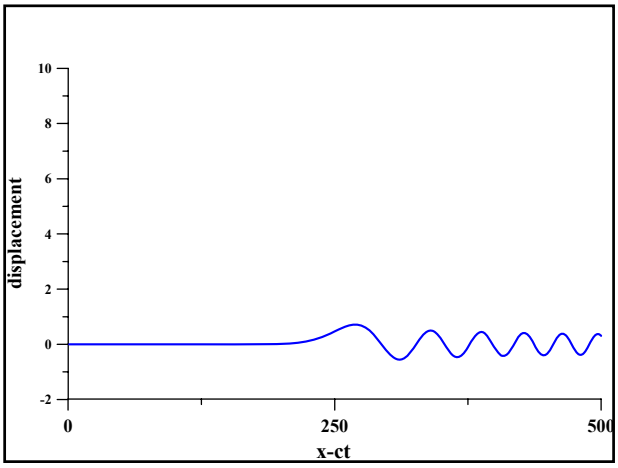
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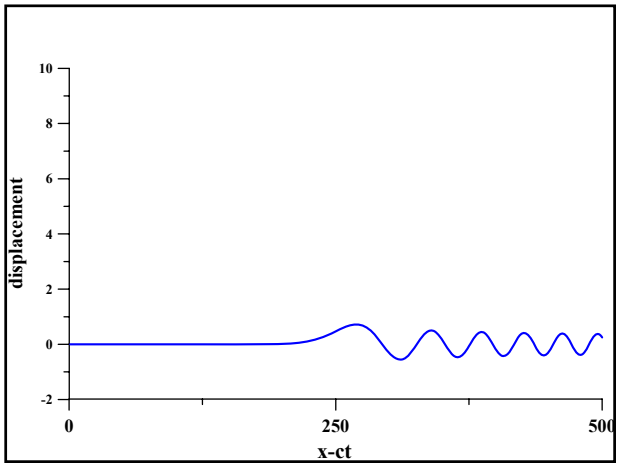
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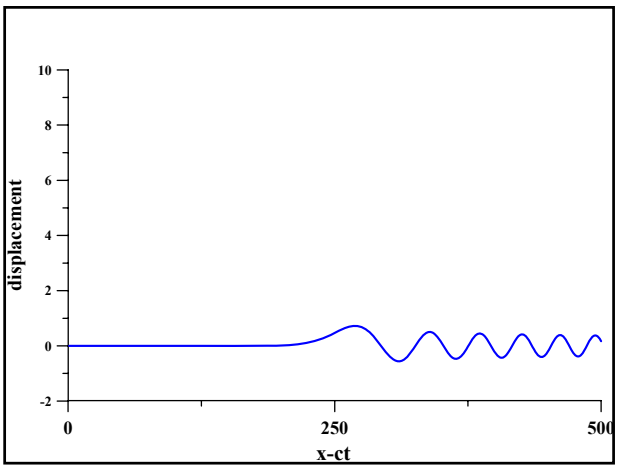
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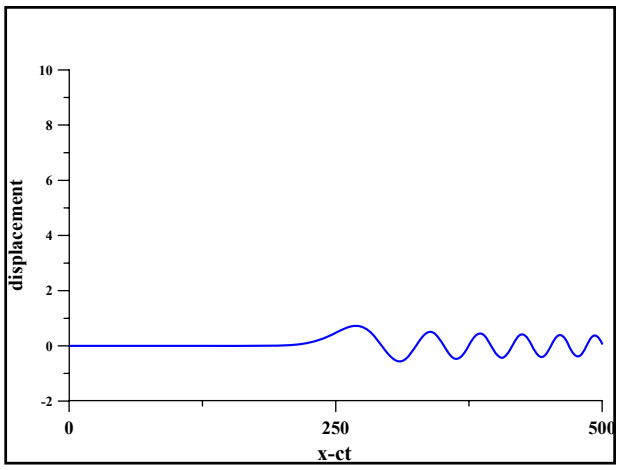
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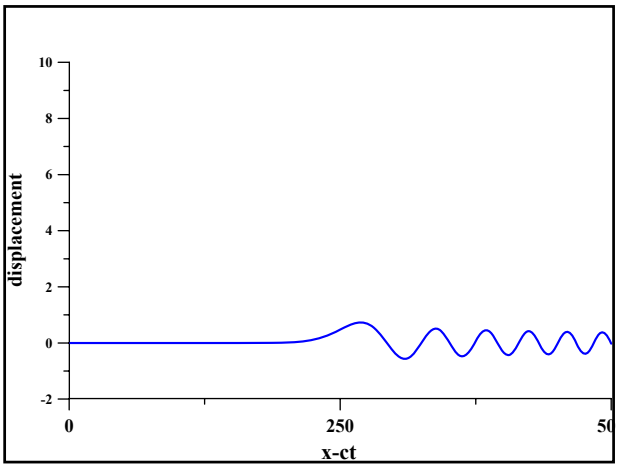
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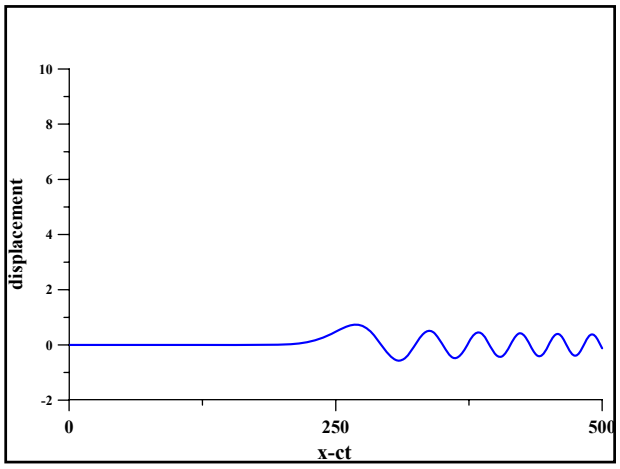
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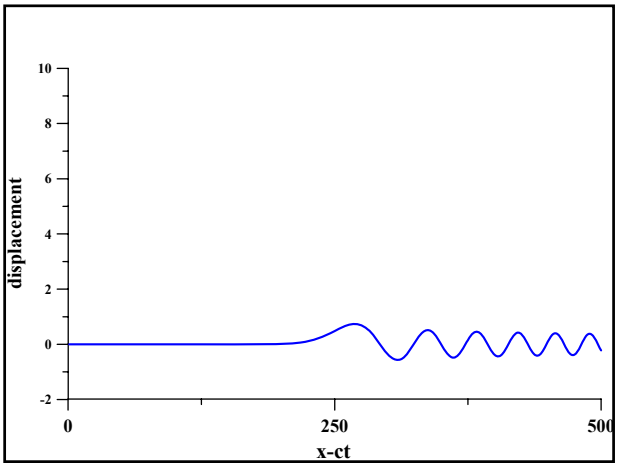
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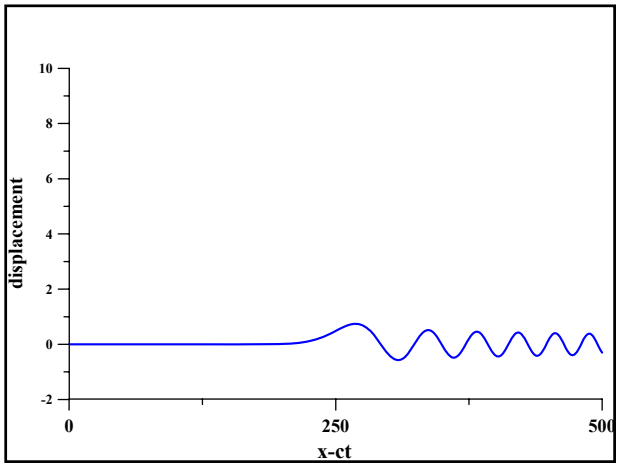
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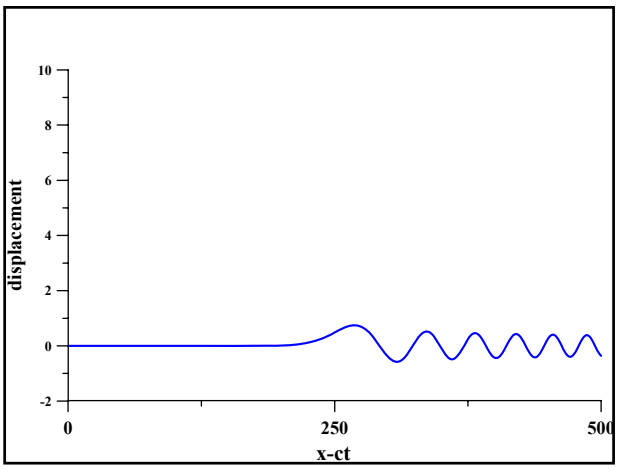
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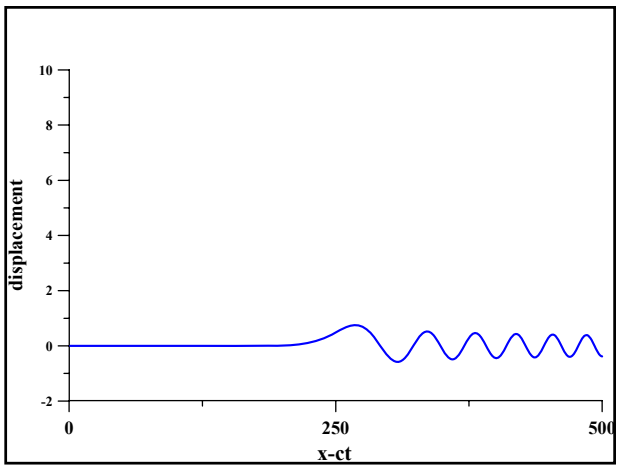
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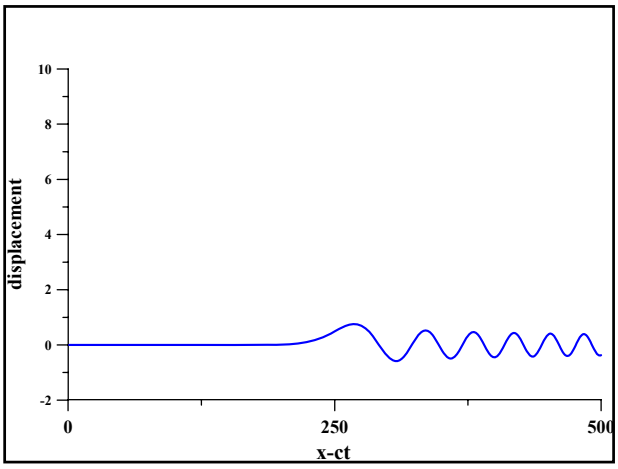
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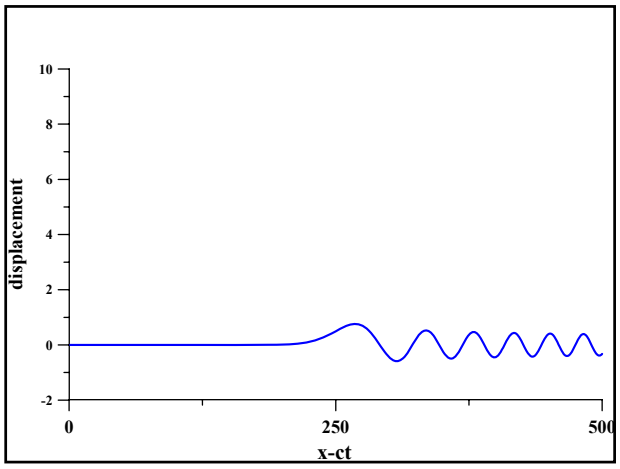
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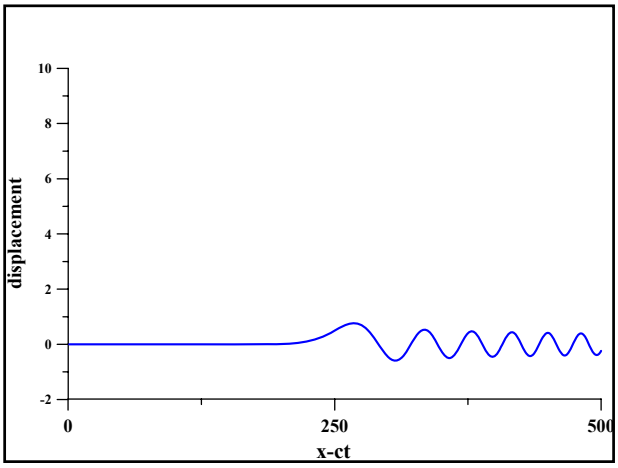
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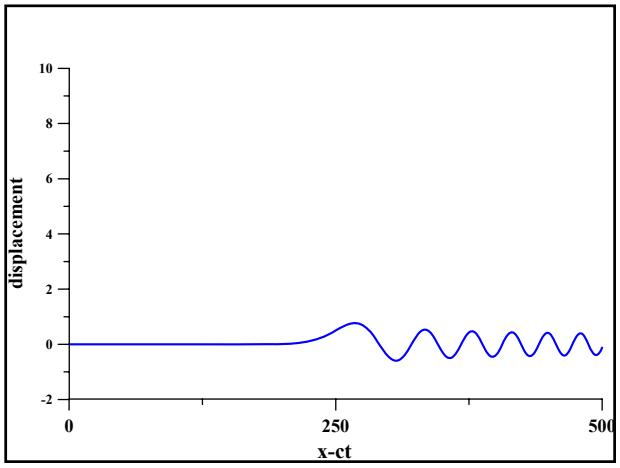
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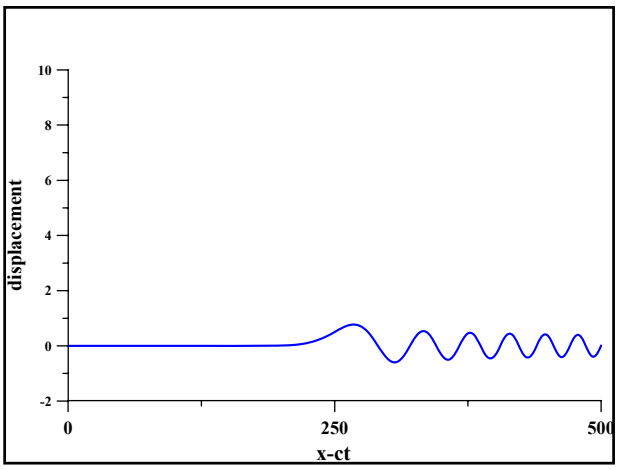
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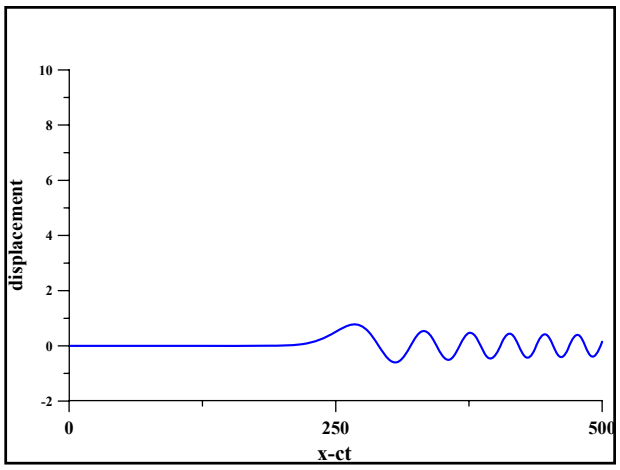
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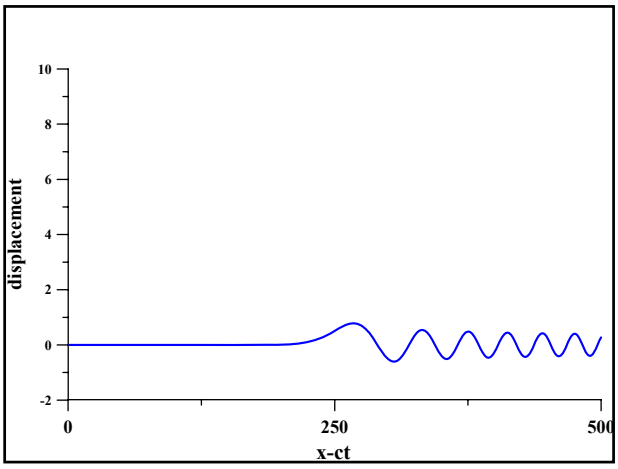
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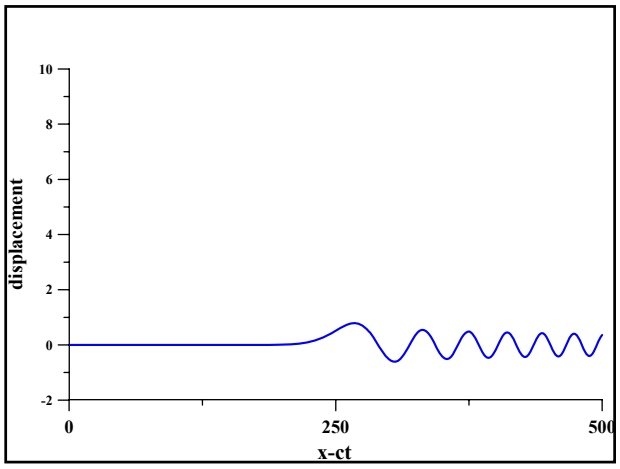
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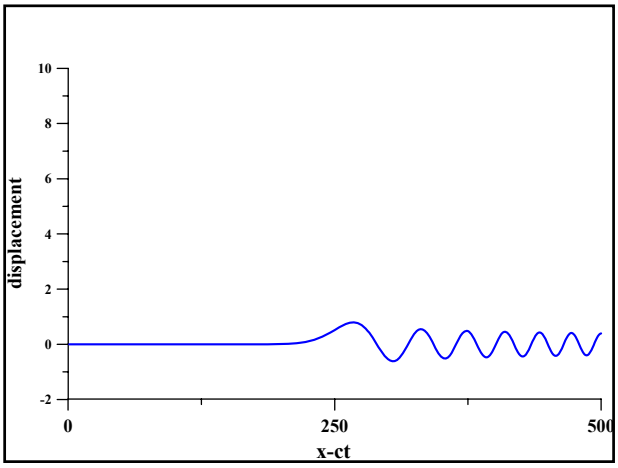
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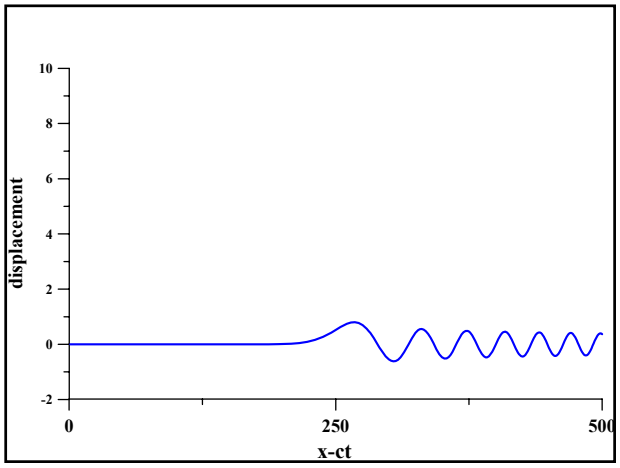
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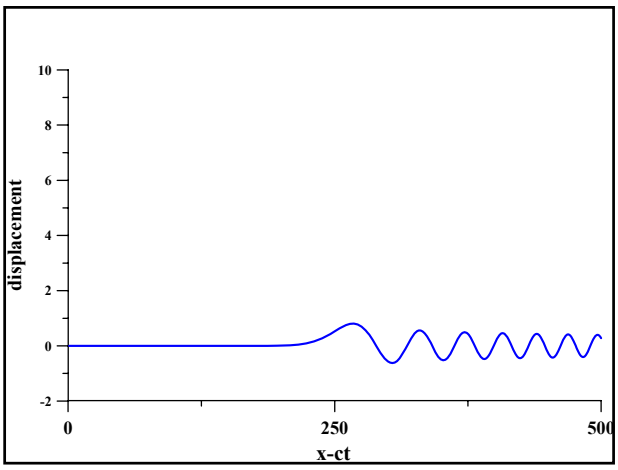
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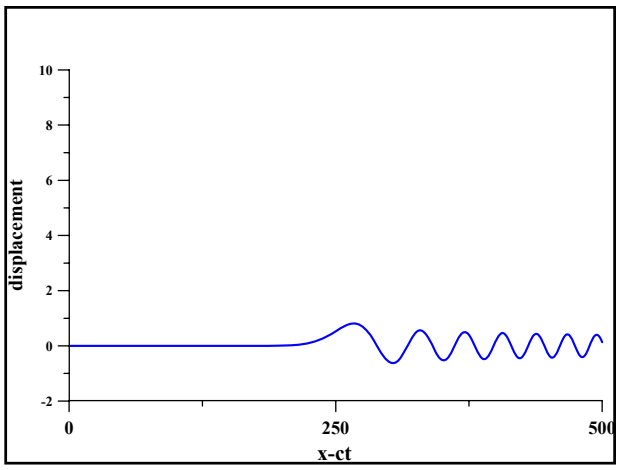
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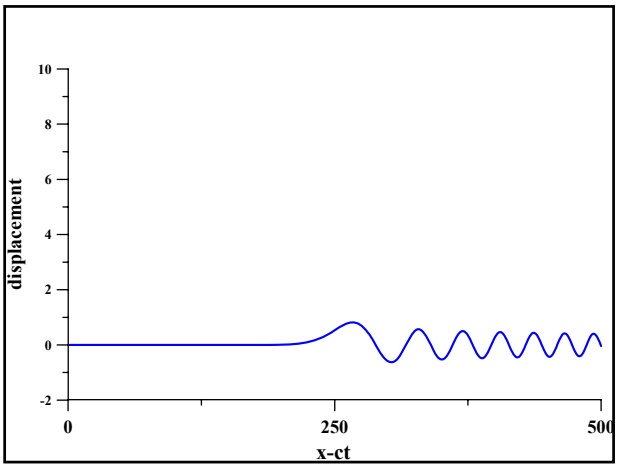
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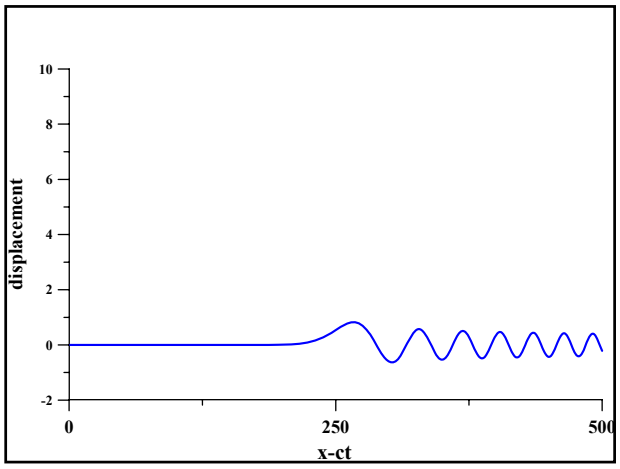
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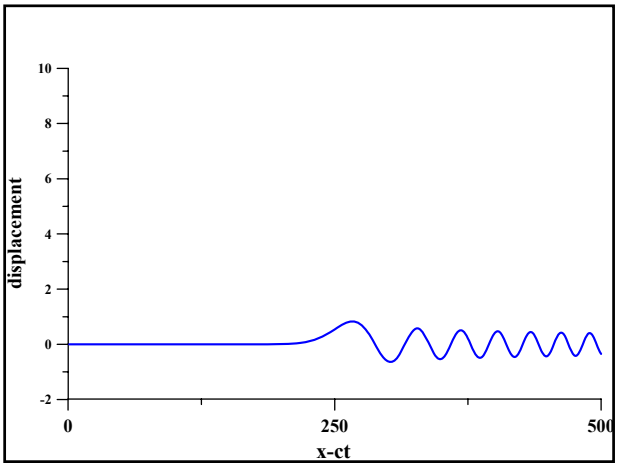
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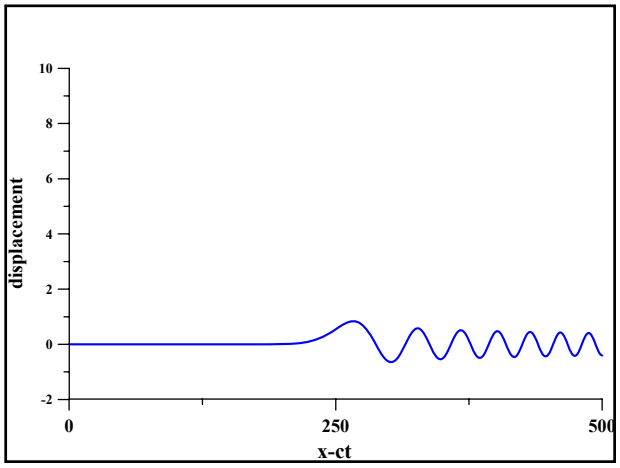
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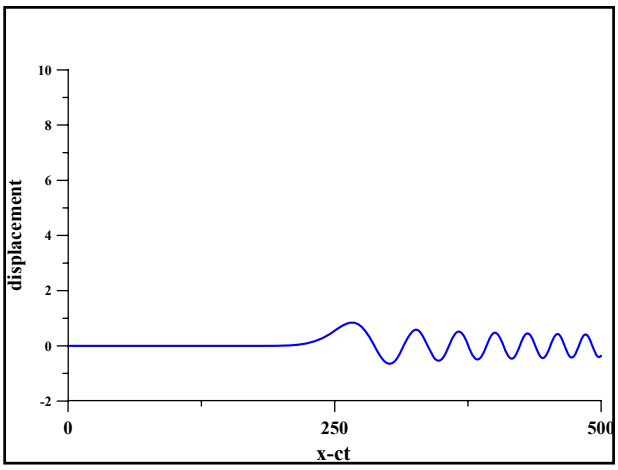
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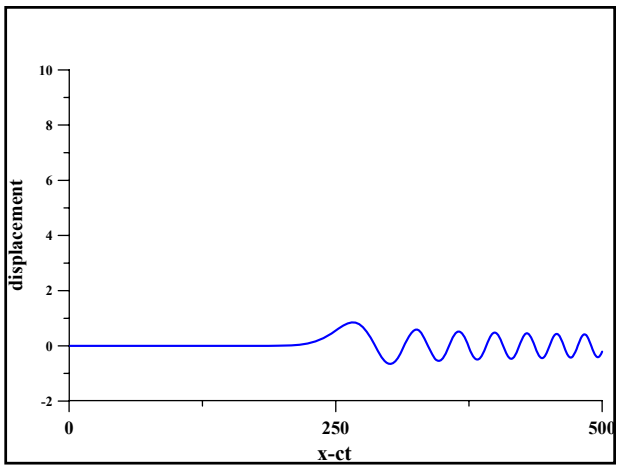
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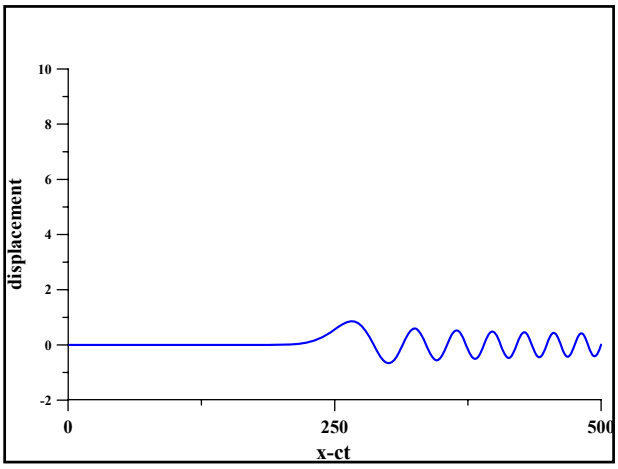
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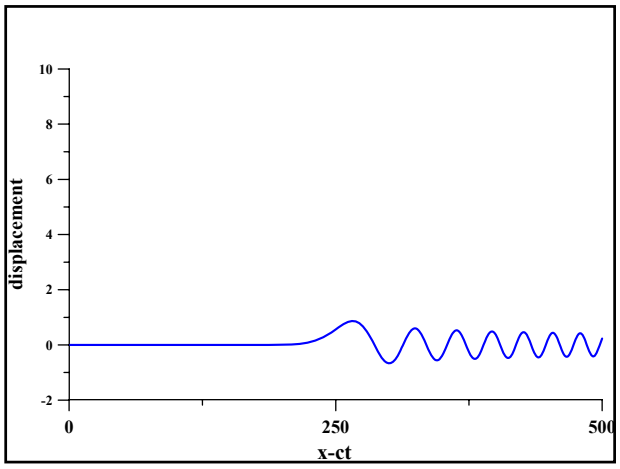
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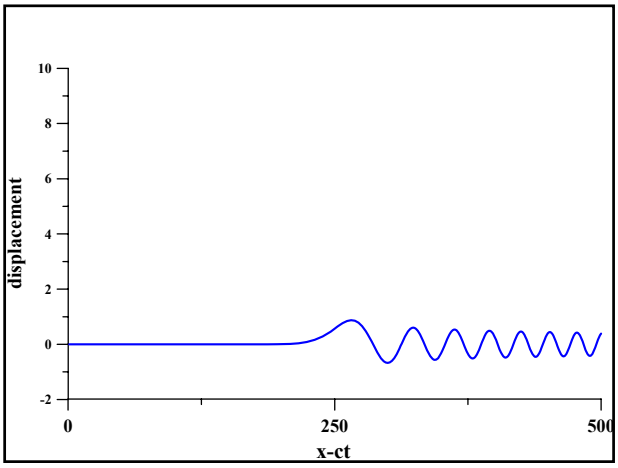
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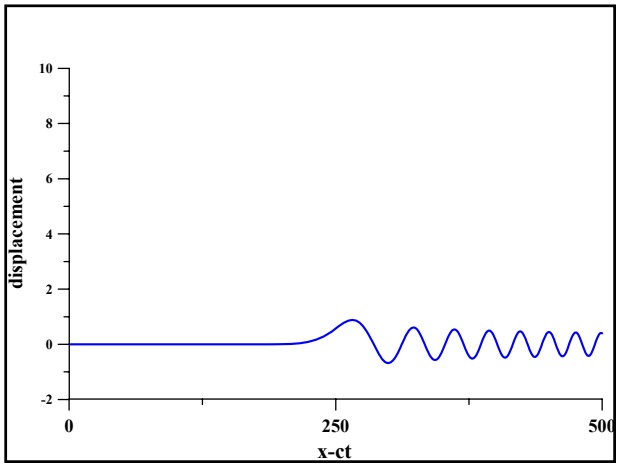
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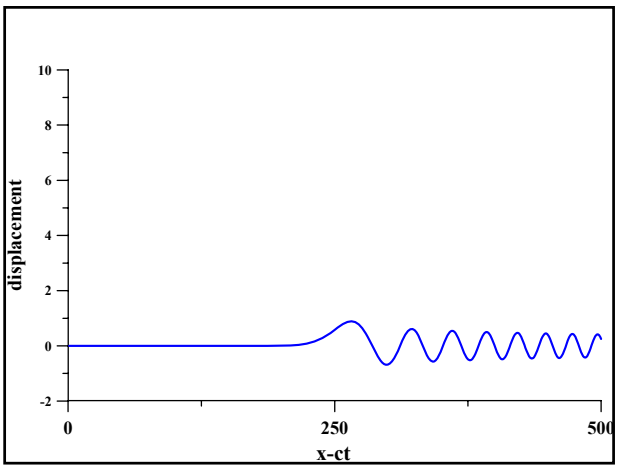
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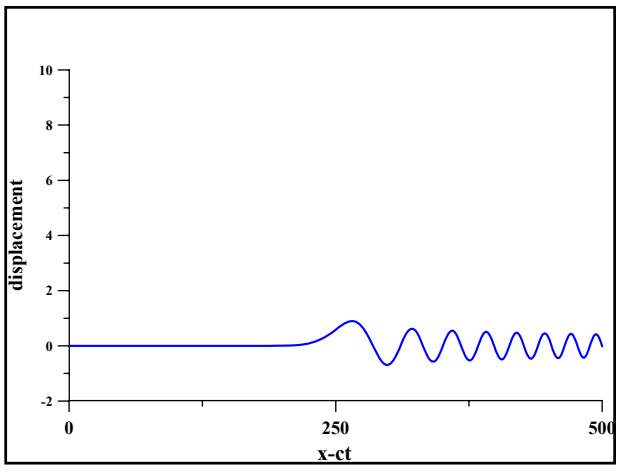
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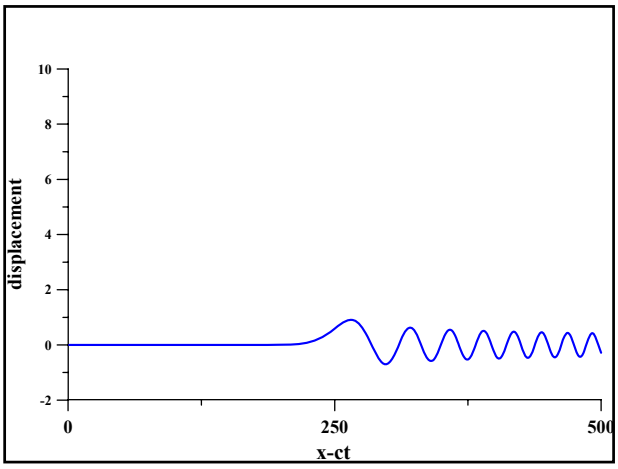
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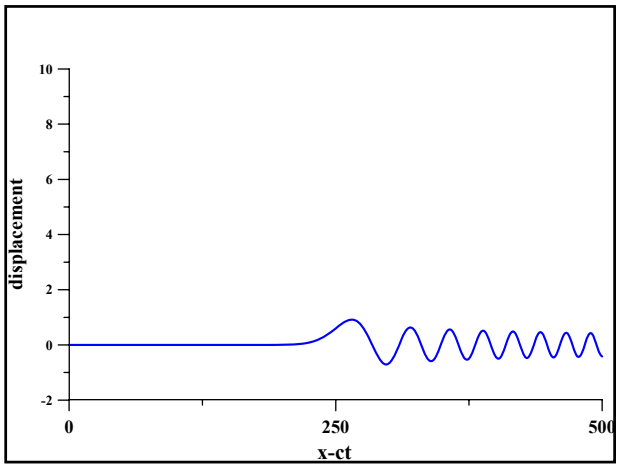
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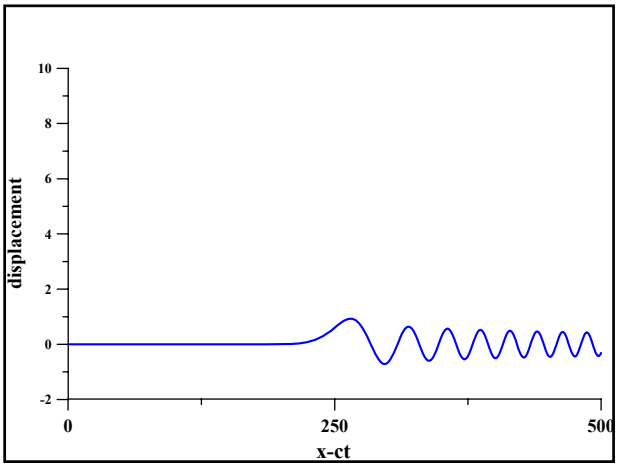
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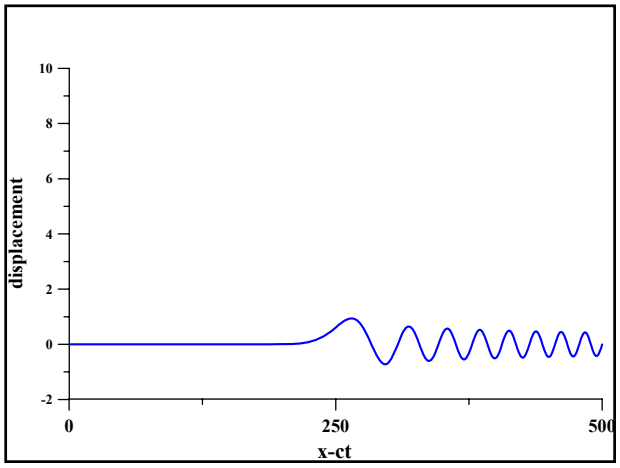
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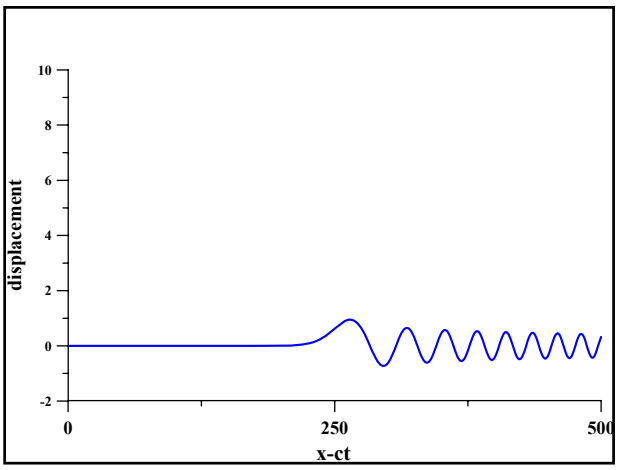
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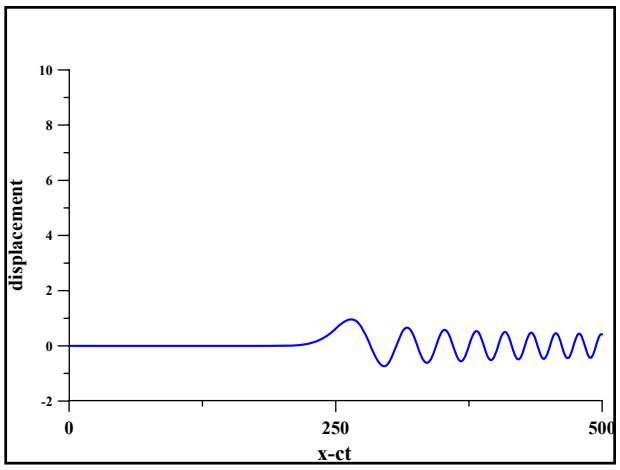
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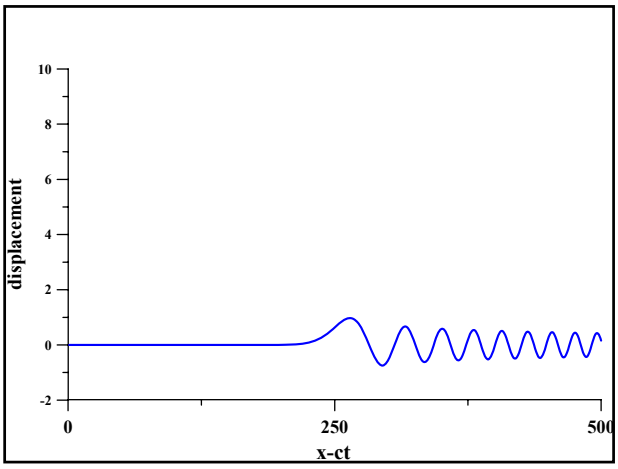
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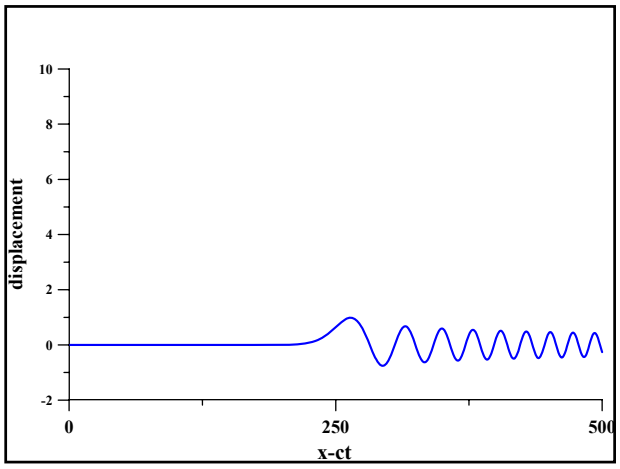
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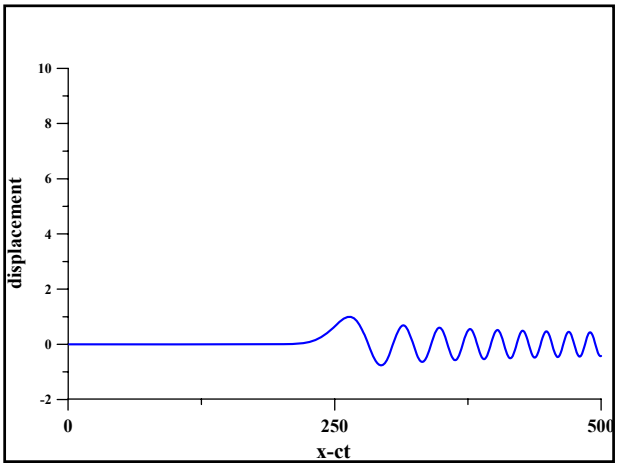
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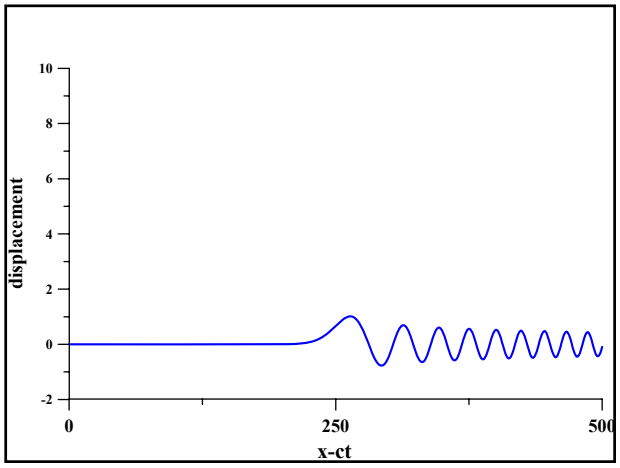
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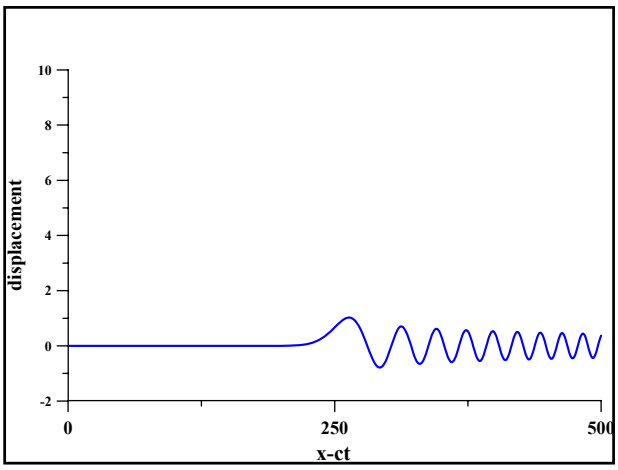
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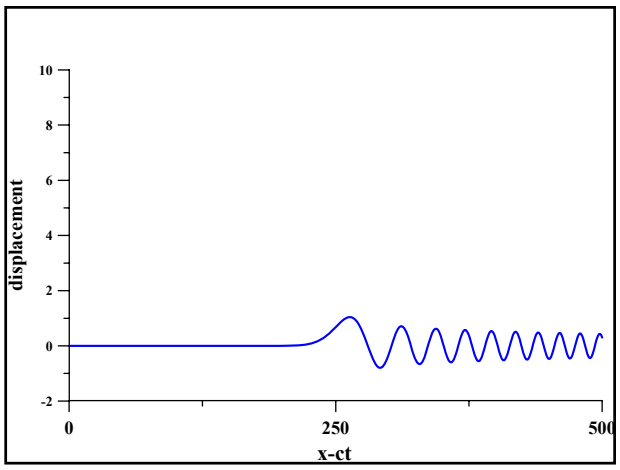
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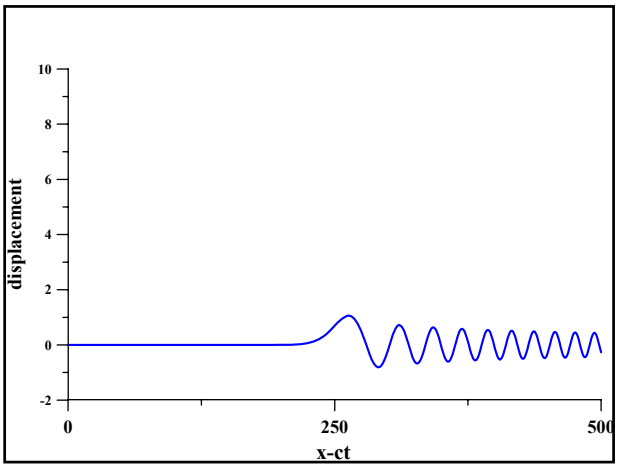
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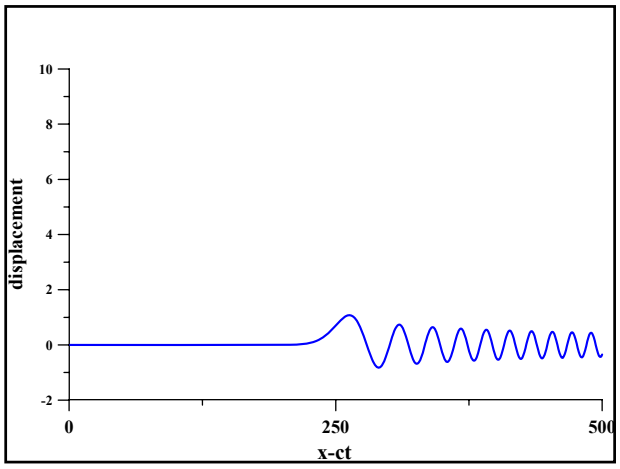
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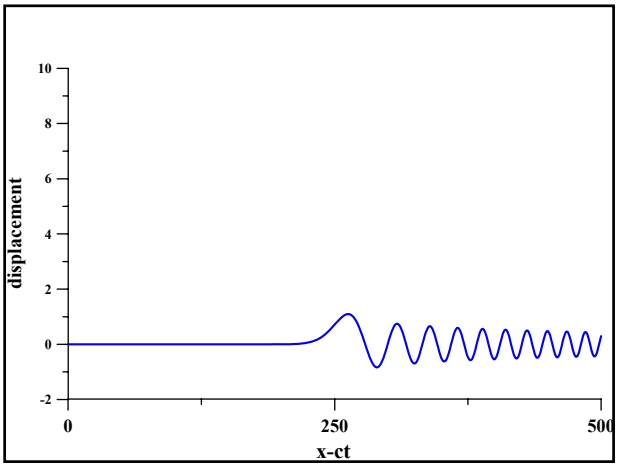
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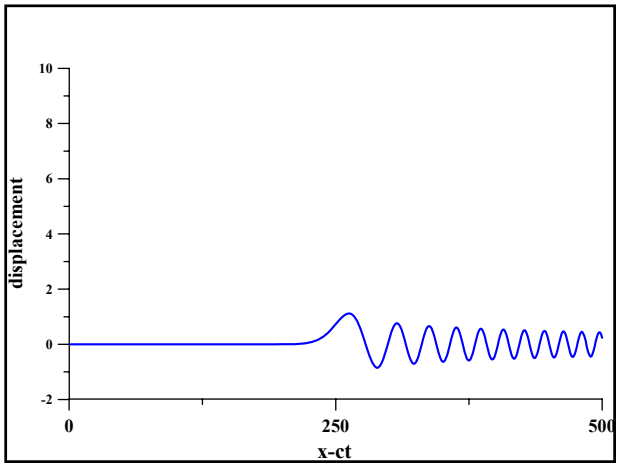
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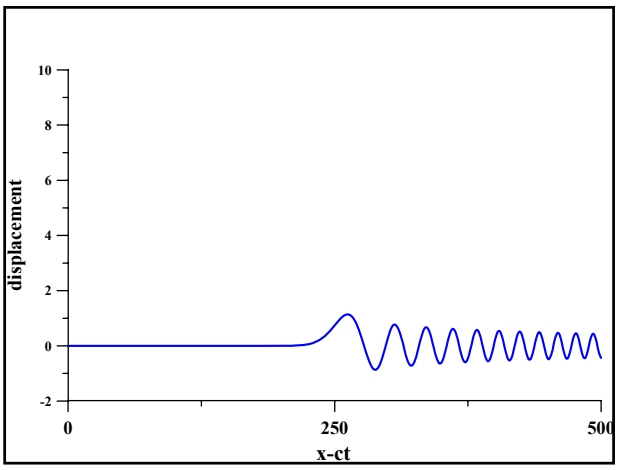
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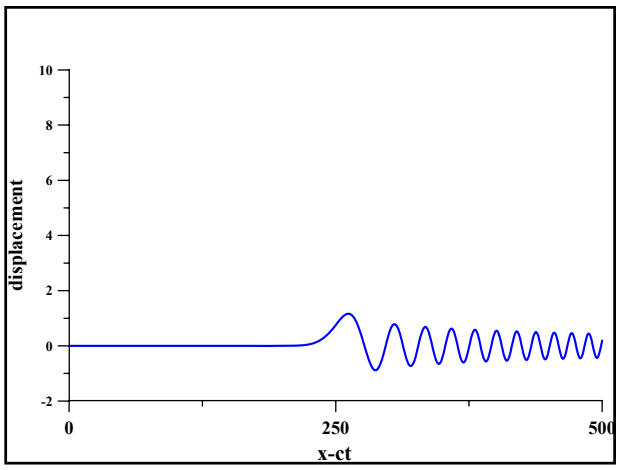
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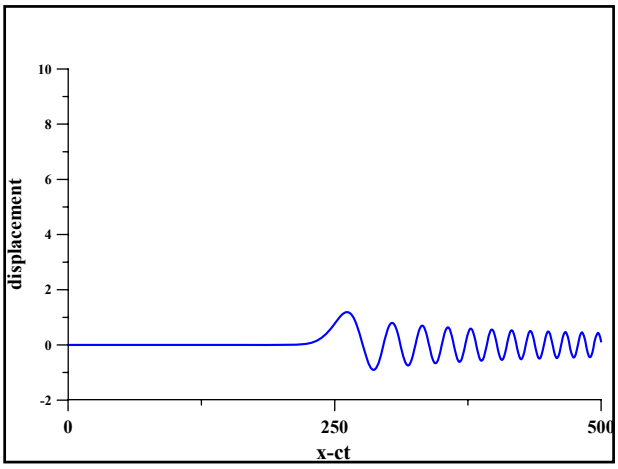
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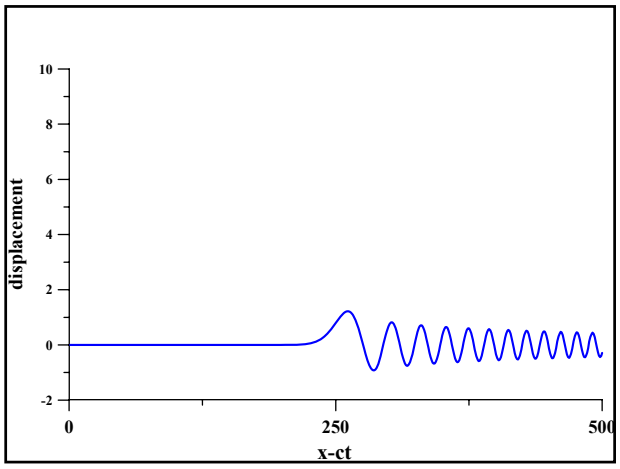
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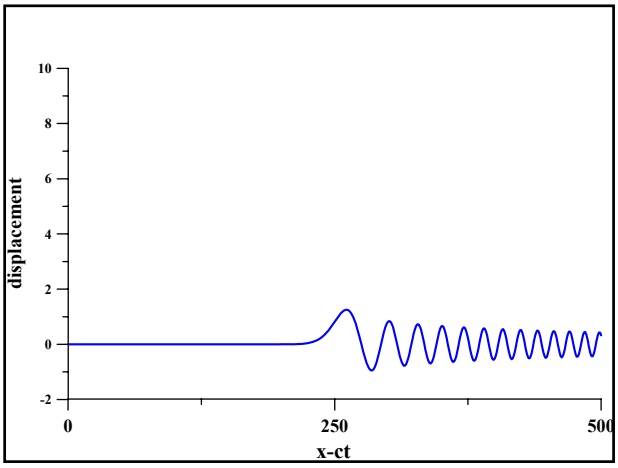
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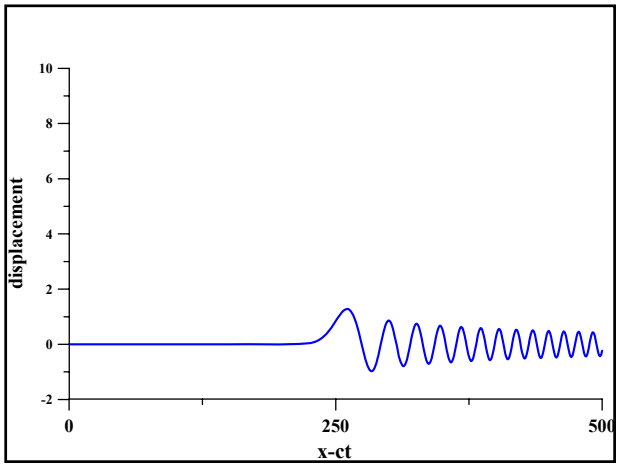
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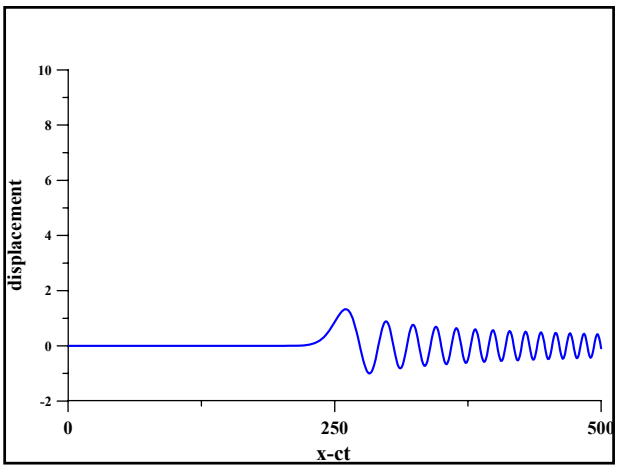
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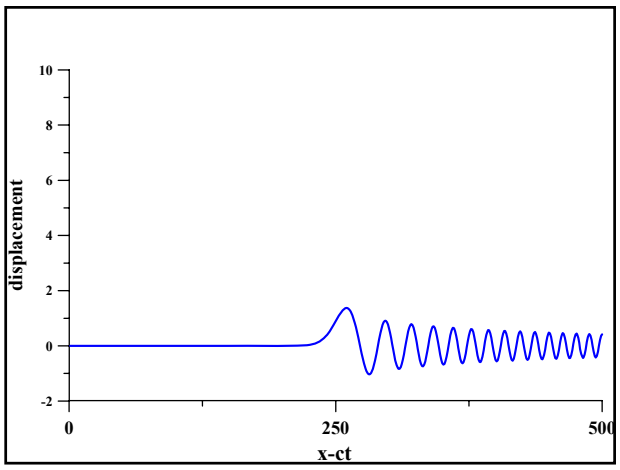
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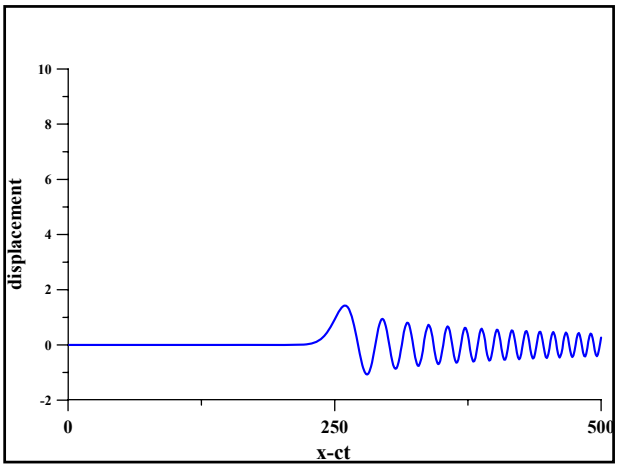
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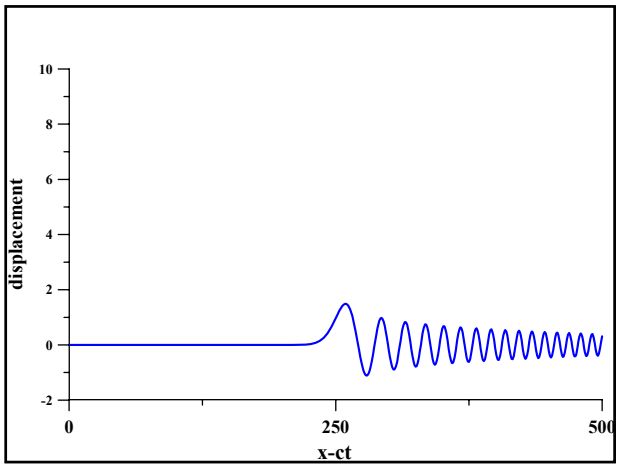
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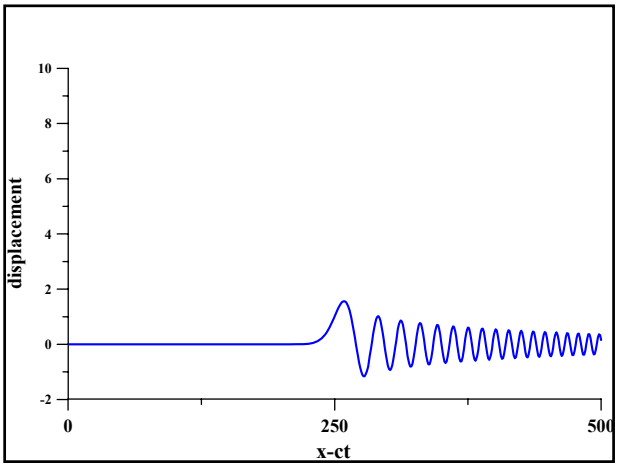
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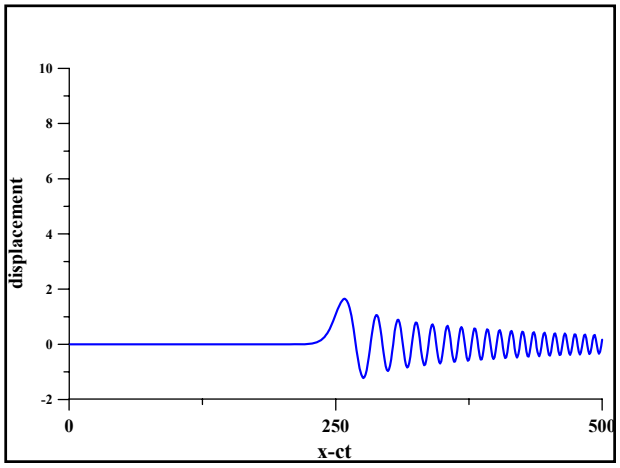
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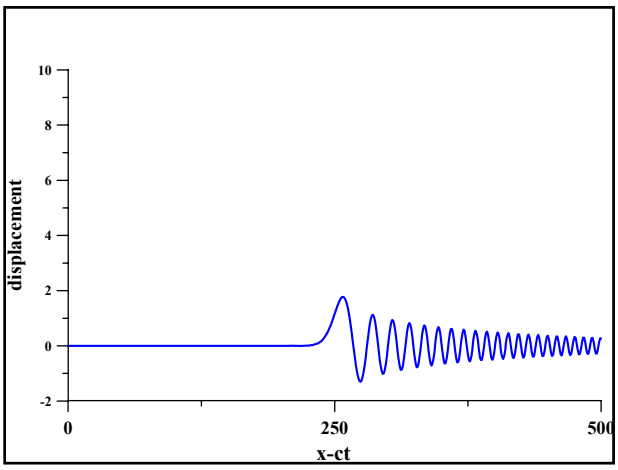
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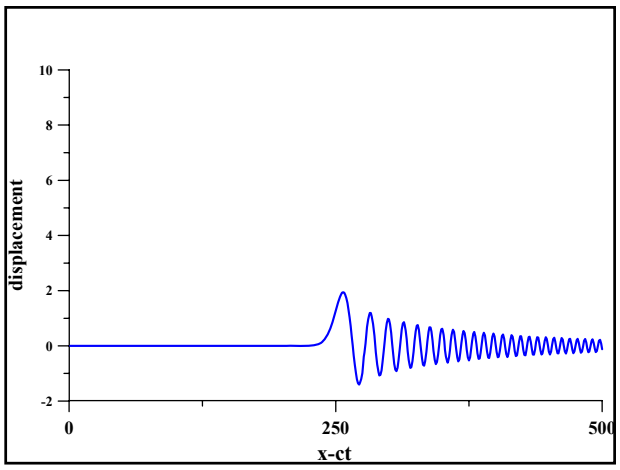
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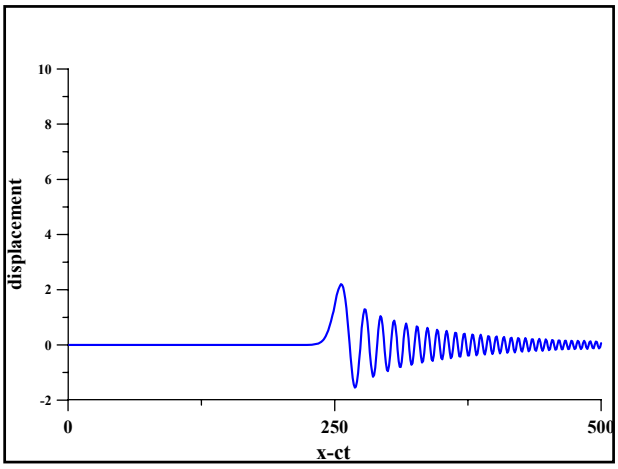
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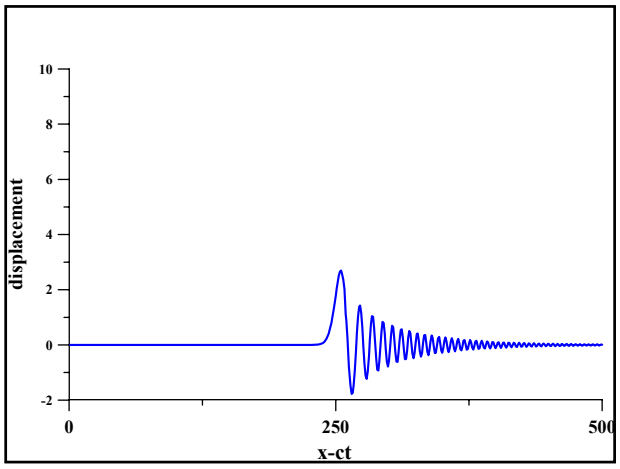
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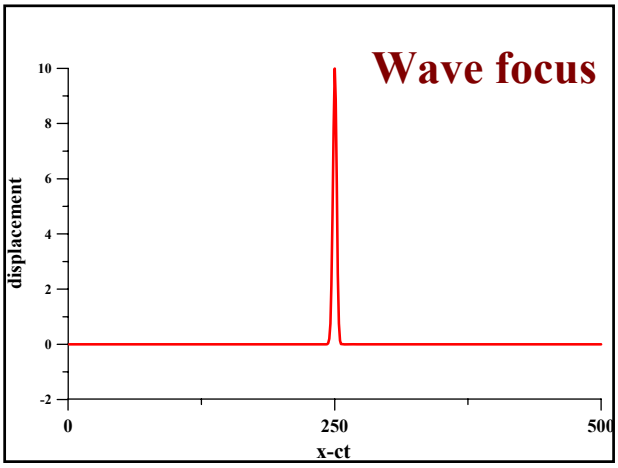
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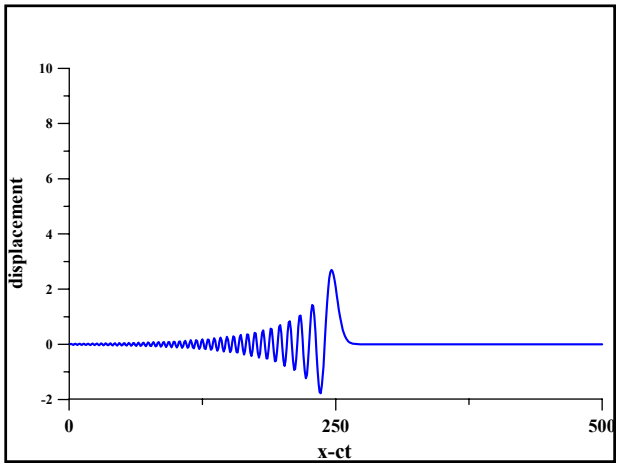
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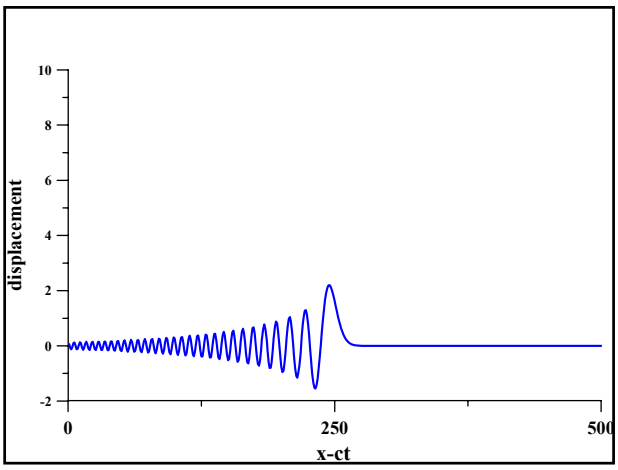
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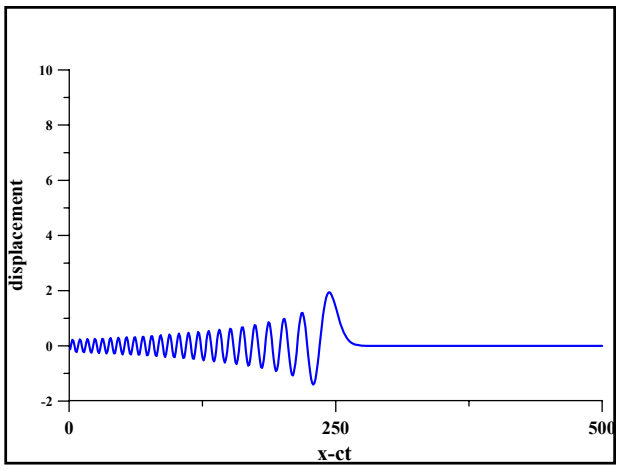
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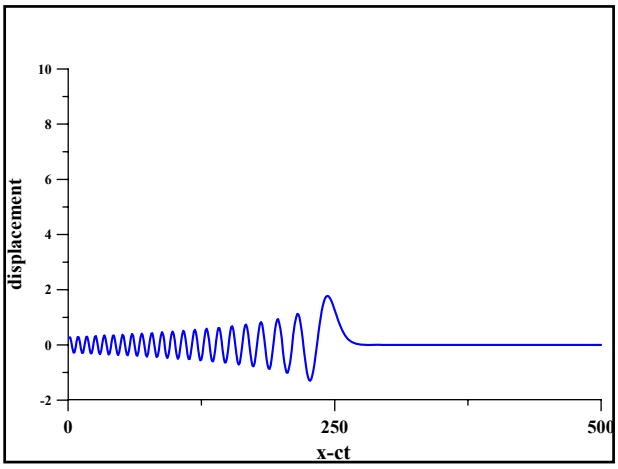
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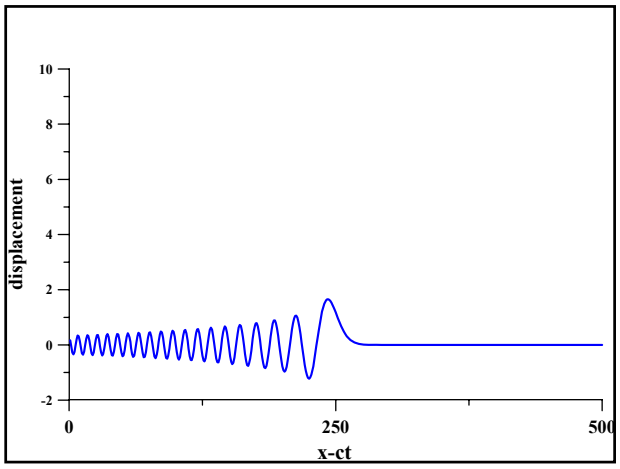
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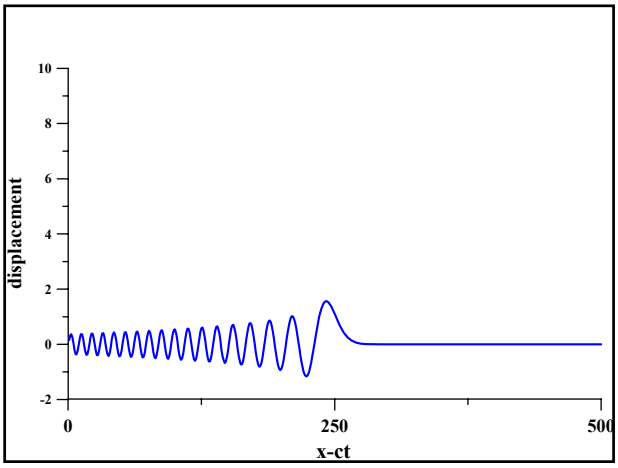
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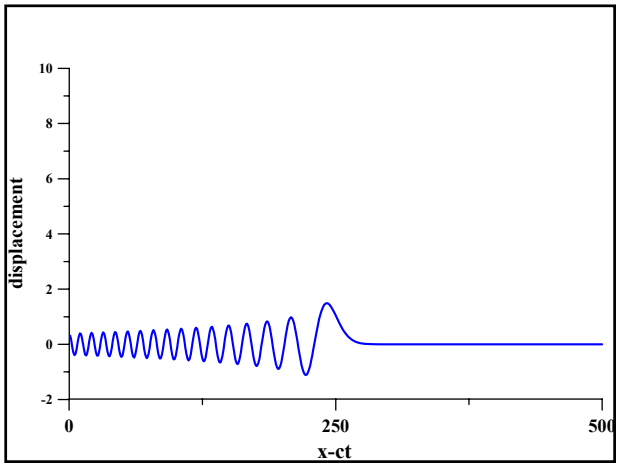
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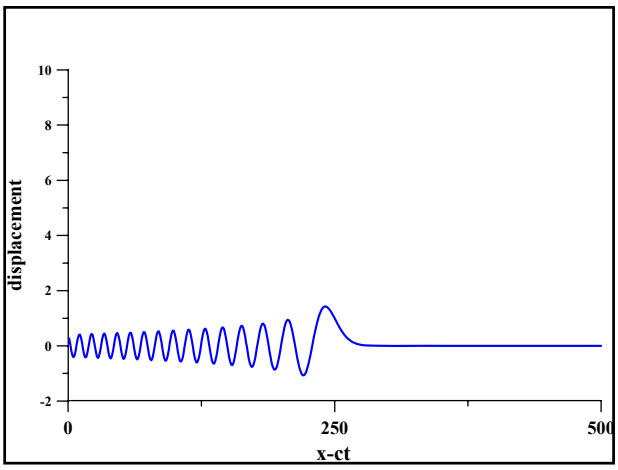
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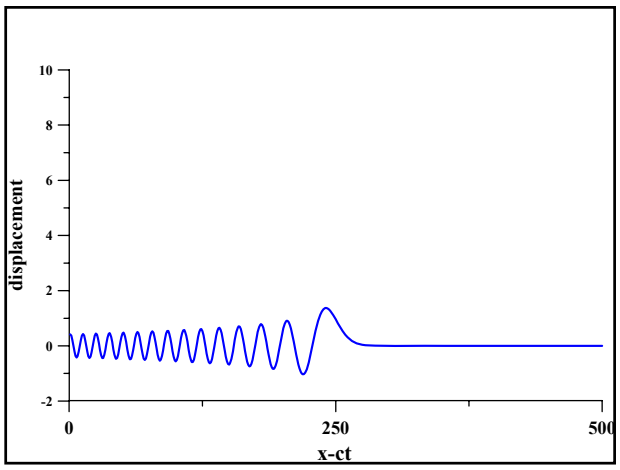
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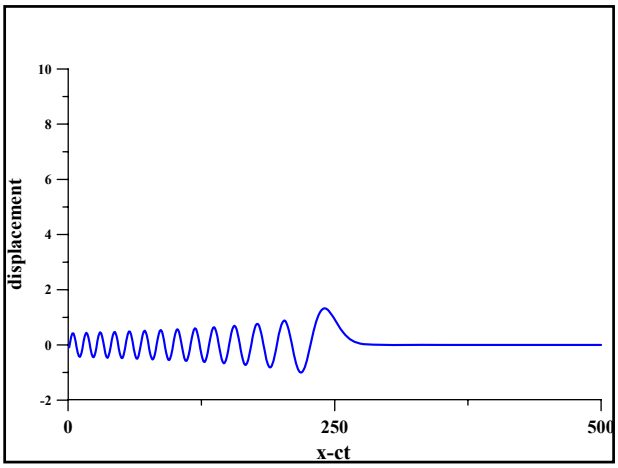
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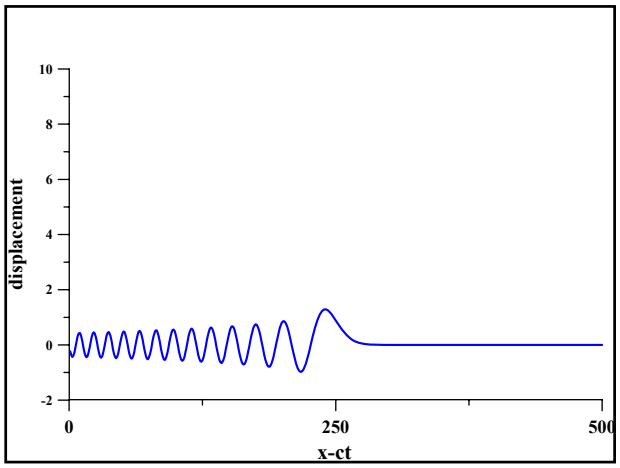
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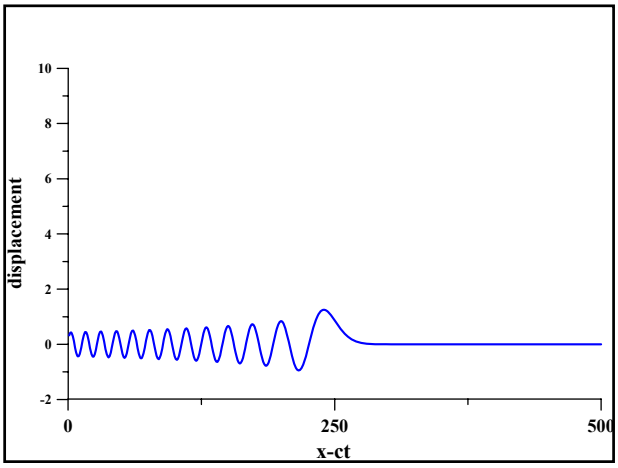
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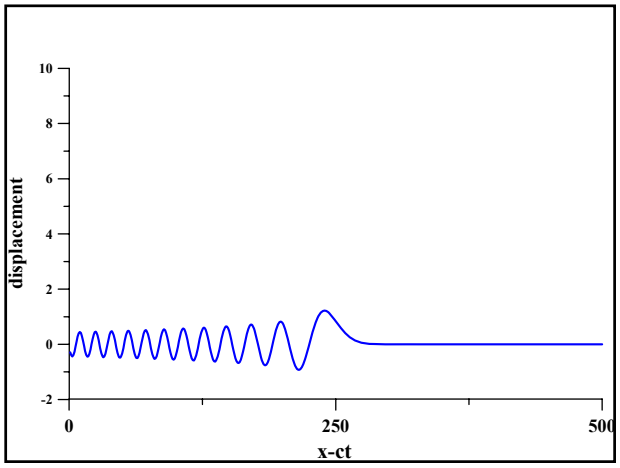
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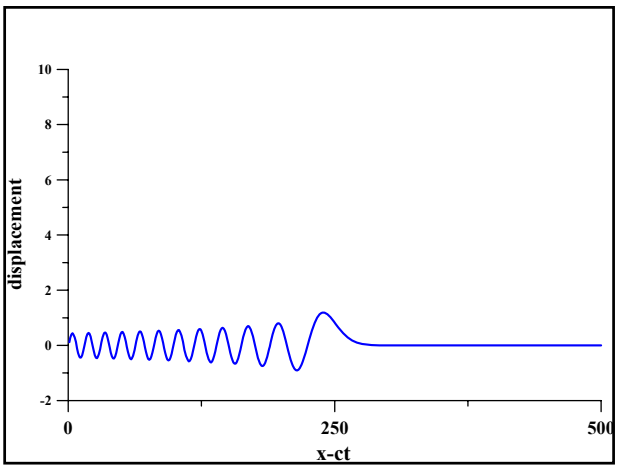
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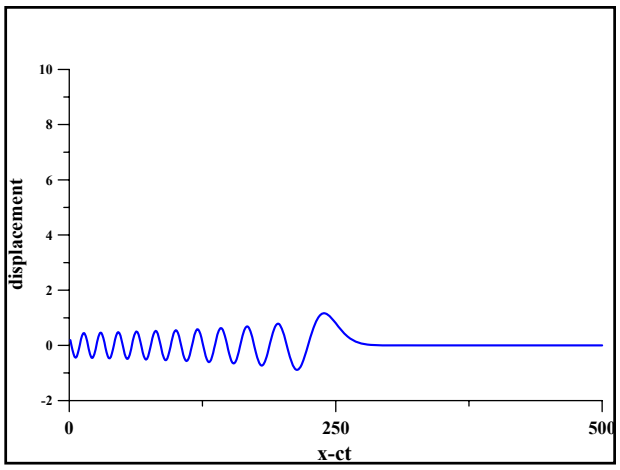
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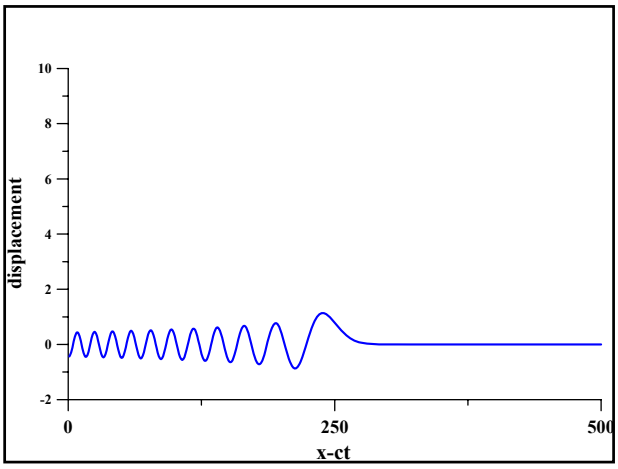
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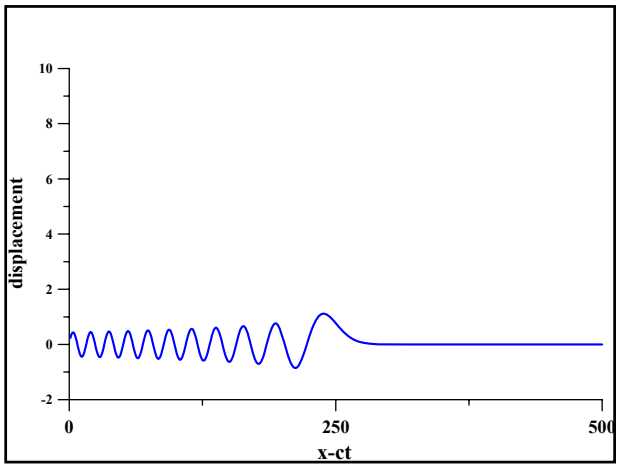
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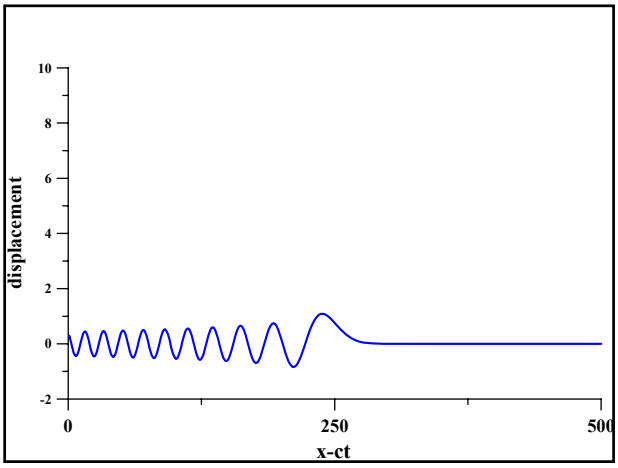
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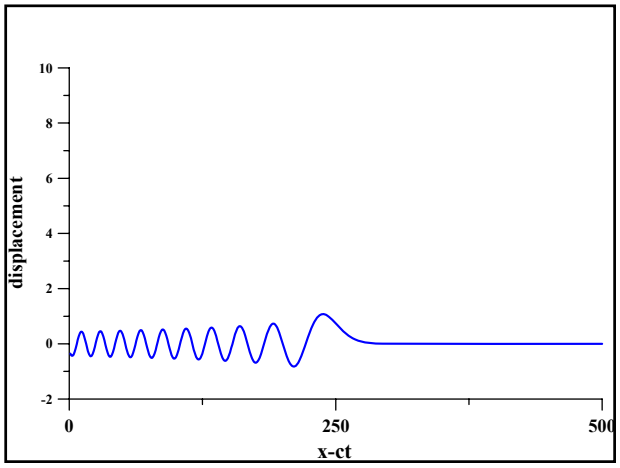
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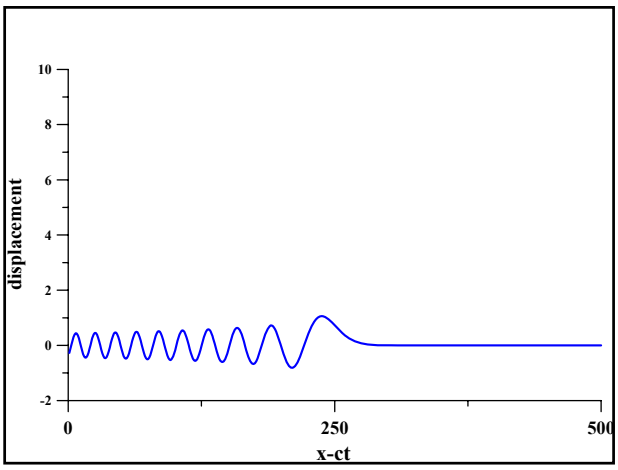
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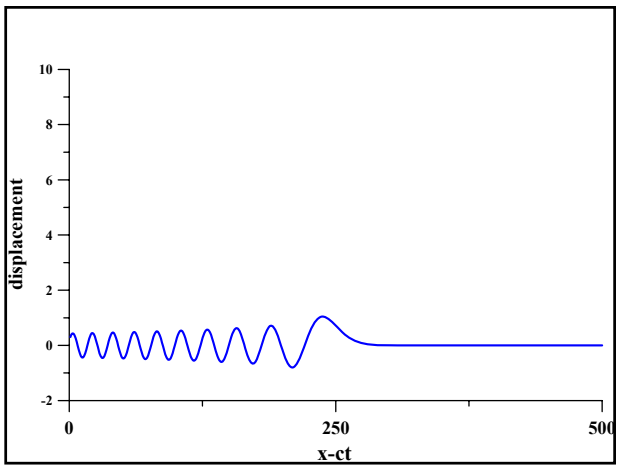
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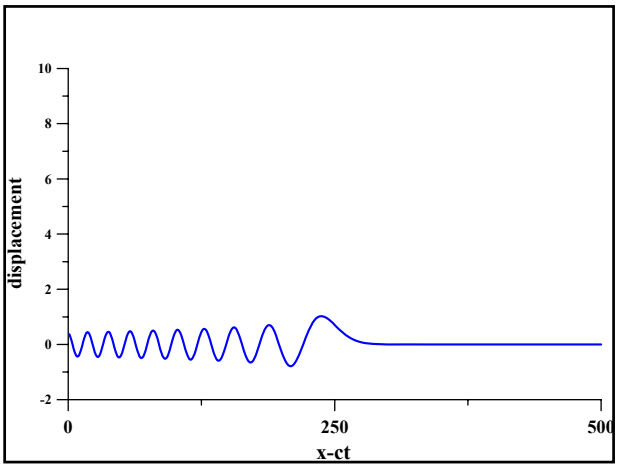
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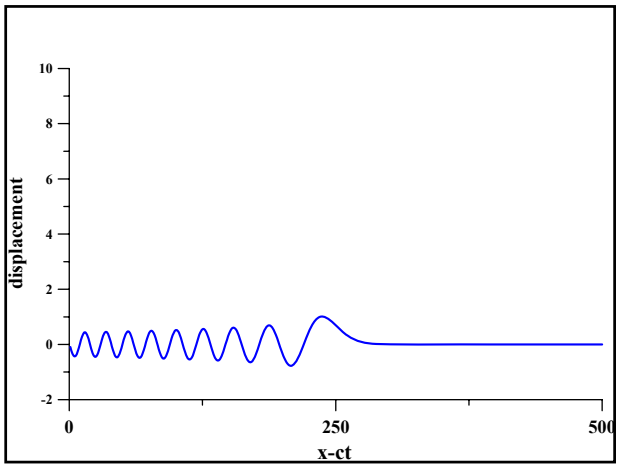
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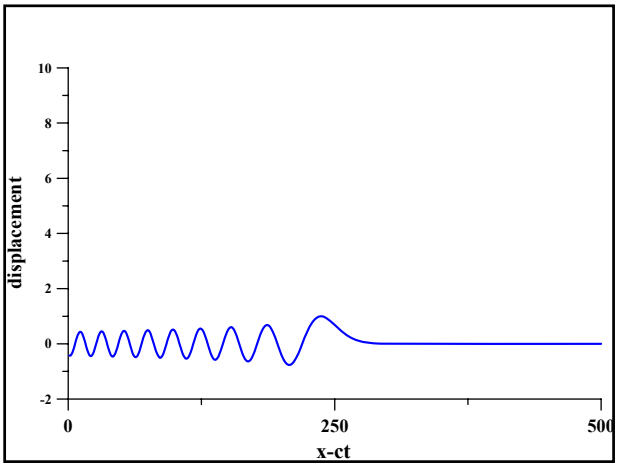
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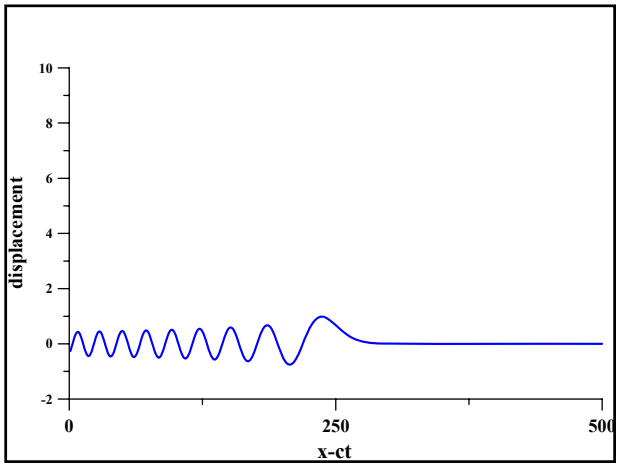
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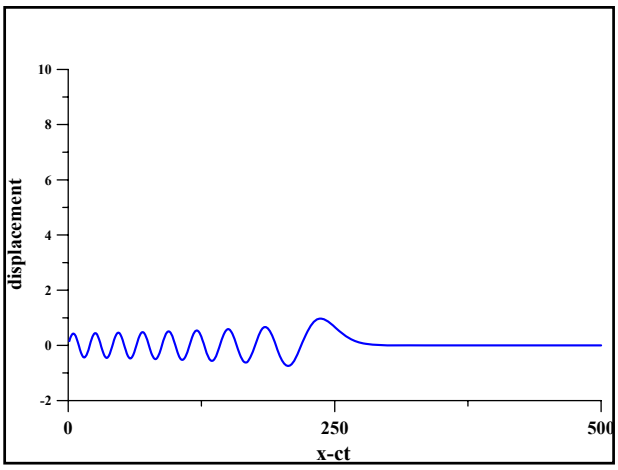
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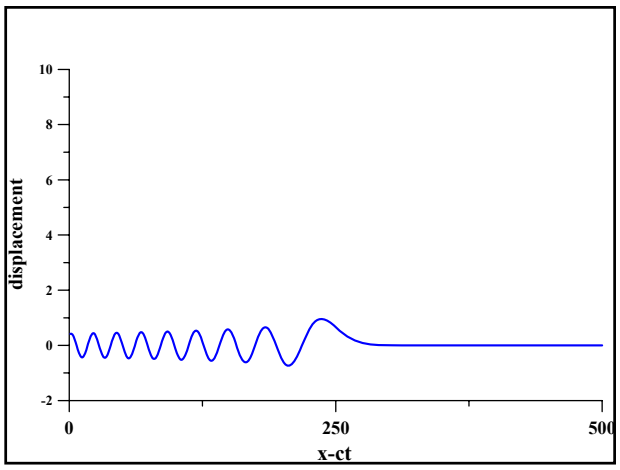
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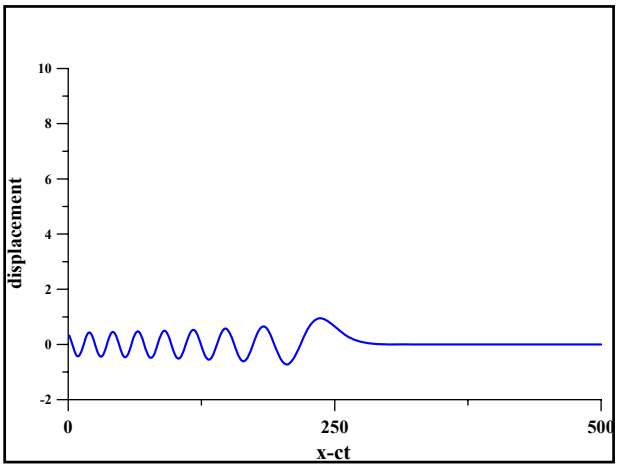
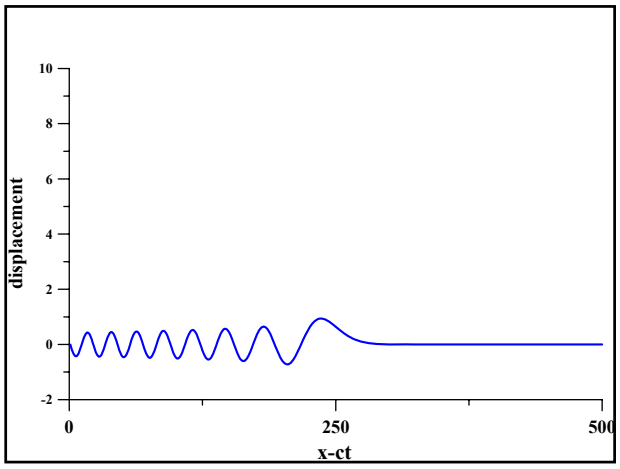
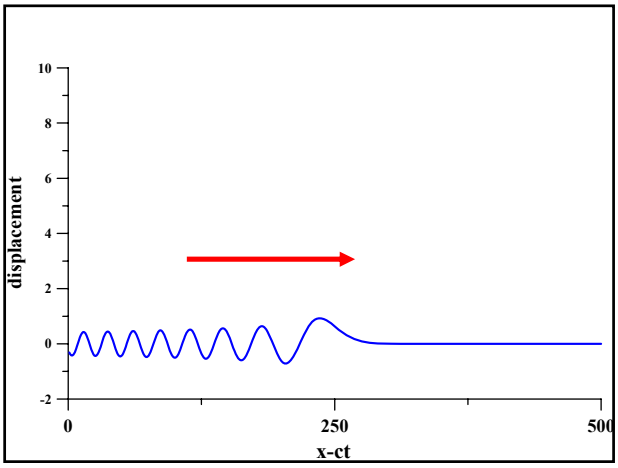
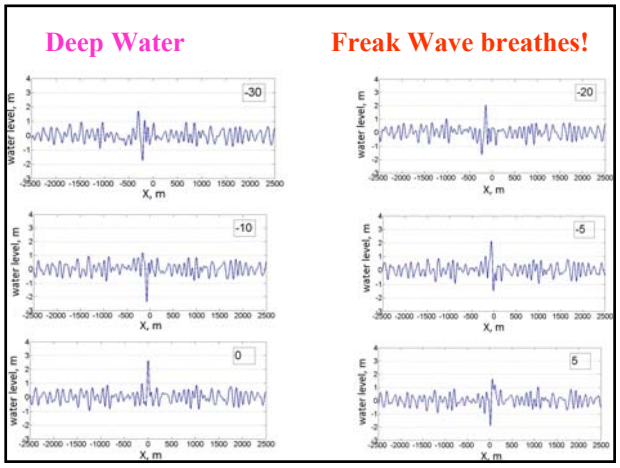








Mechanisms:

- **Wave – current interaction**
  - wave blocking,
  - random caustics.
- **Wave – bottom interaction**
  - focuses, shallow water only
  - random caustics.
- **"Itself" wave dynamics**
  - temporal-spatial focusing,
  - modulation instability. deep water only

Nonlinear waves in deep water

$$iq_t + q_{xx} + 2q|q|^2 = 0$$

Nonlinear Schrodinger Equation for kA

Integrable model

$$\frac{d\Psi_1}{dx} = \lambda\Psi_1 - q(x)\Psi_2 \qquad \frac{d\Psi_2}{dx} = \lambda\Psi_2 + q^*(x)\Psi_1$$

Benjamin – Feir instability:

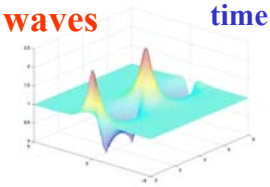
Sine wave transforms to solitons and breathers

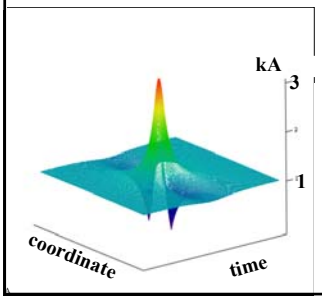
Nonlinear abnormal waves

time

(exact breathers)

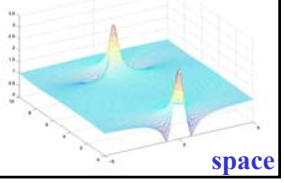
Peregrine





Kuznetsov

Ma

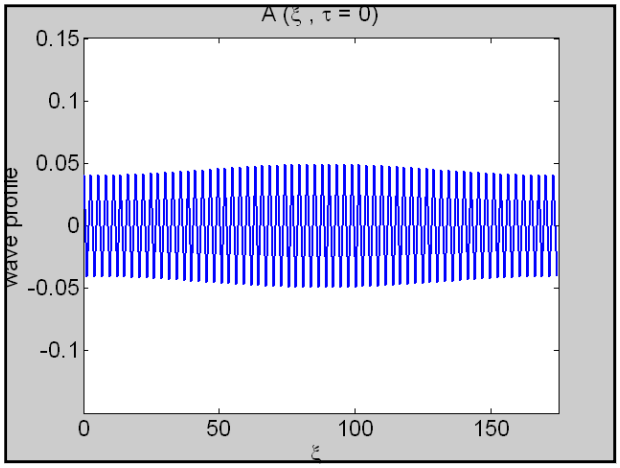


space

Nonlinear Schrodinger equation

Modelling of the Benjamin – Feir instability: amplitude modulation

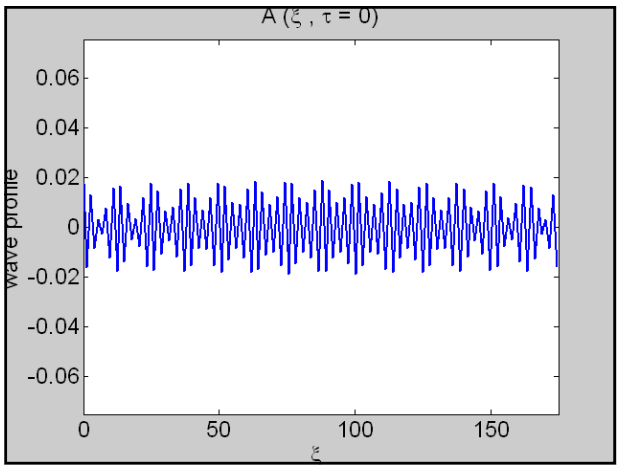
$$A(x,0) = A_0\left(1 + m\sin(Kx)\right)$$



Nonlinear Schrodinger equation

Modelling of wave focusing: phase (frequency) and amplitude modulation

$$A(x,0) = A_0\left(1 + m\sin(Kx)\right)\exp\left(\frac{ix^2}{D^2}\right)$$



A Freak Wave in 2 Dimensions

The Davey – Stewartson equations

Benney & Roskes (1969) Davey & Stewartson (1974)

$$iq_t + D_1 q_{xx} - D_2 q_{yy} + 2q\left(N_1|q|^2 + N_2 P_x\right) = 0$$

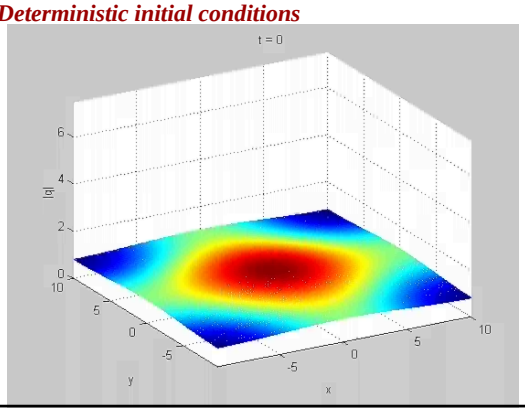
$$S_1 P_{xx} + S_2 P_{yy} = -N_2 \frac{\partial}{\partial x}|q|^2$$

D_1, D_2, N_1, N_2, S_1 and S_2 are functions of the value kh

$q(x, y, t)$ is proportional to the amplitude of a wave packet

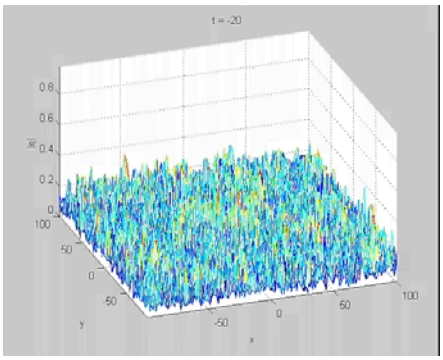
2D Nonlinear Schrödinger equation

Deterministic initial conditions



2D Nonlinear Schrödinger equation

Random initial conditions + weak coherent component



The simplest equations for nonlinear surface waves

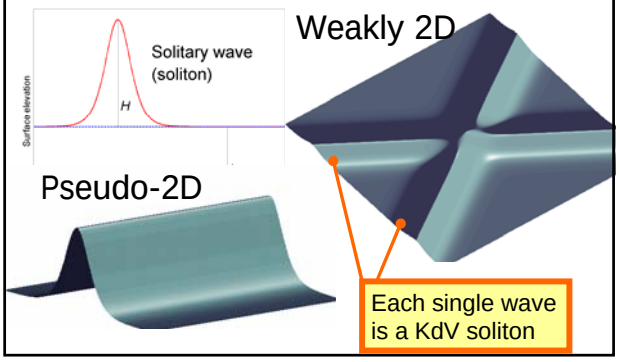
Korteweg-de Vries (KdV) equation (1+1D)

$$\eta_t + 6\eta\eta_x + \eta_{xxx} = 0$$

Kadomtsev-Petviashvili equation (weak 2+1D)

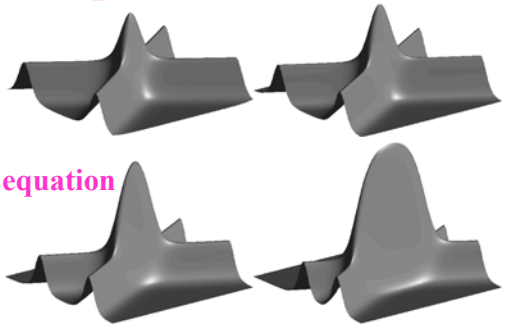
$$\left(\eta_t + 6\eta\eta_x + \eta_{xxx}\right)_x + 3\eta_{yy} = 0$$

KdV Solitons KP



Wave height increases drastically:

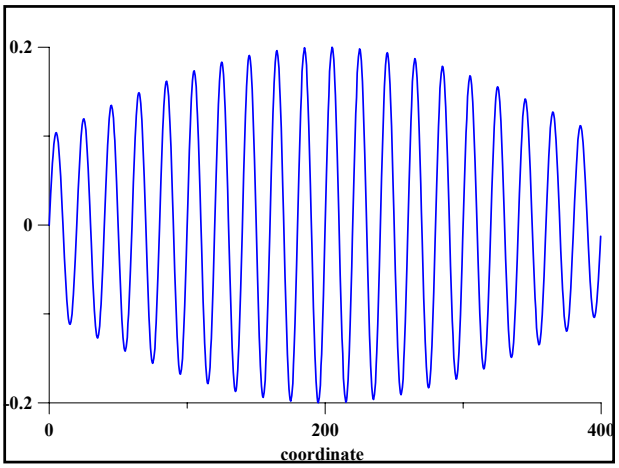
up to four times

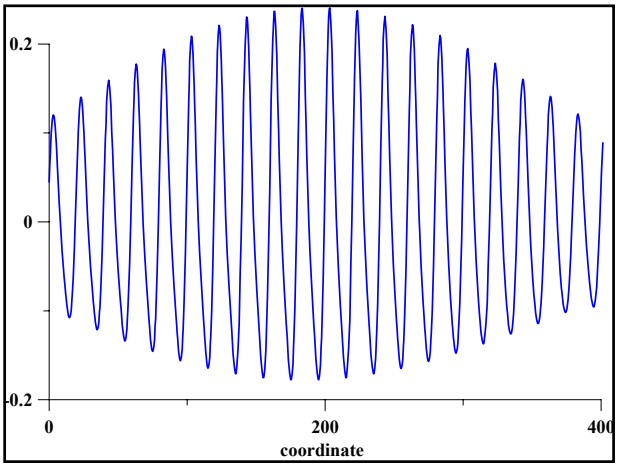


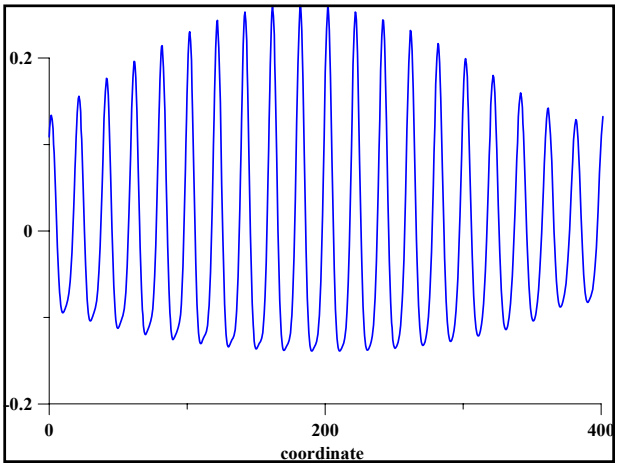
Korteweg – de Vries equation

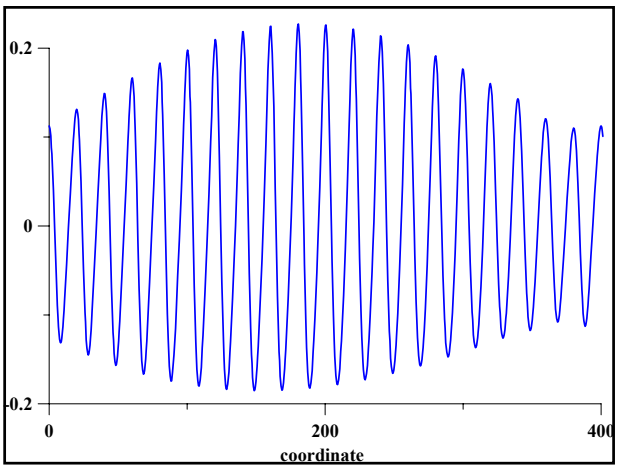
Modulated wave field:
no Benjamin – Feir instability

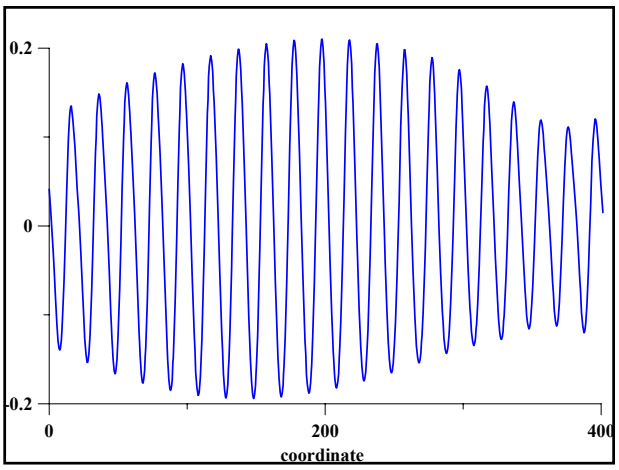
$$A(x,0) = A_0\left(1 + m\sin(Kx)\right)$$

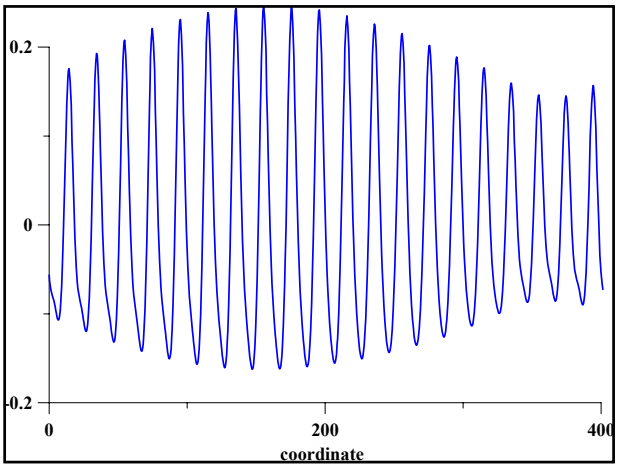








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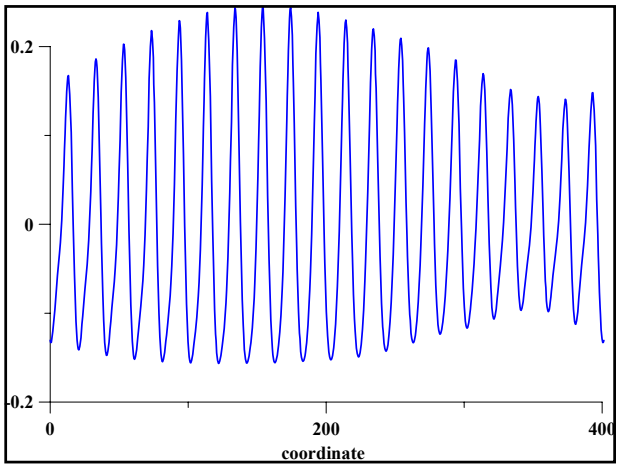
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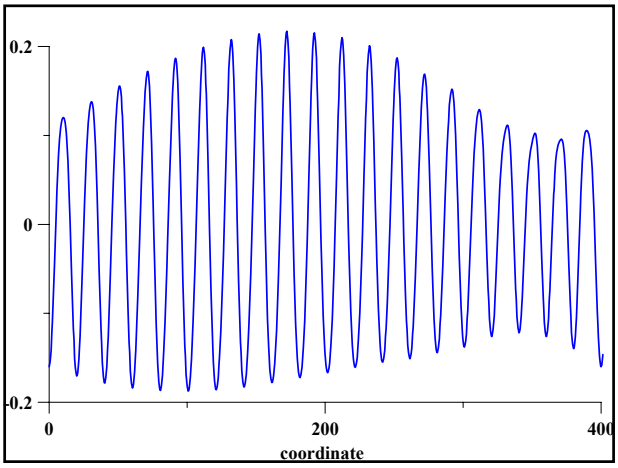
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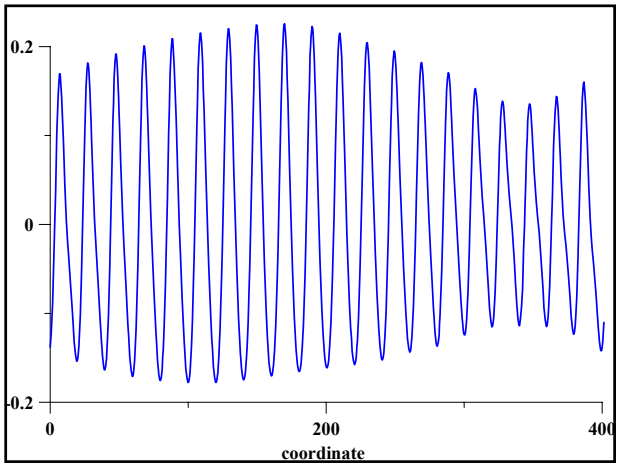
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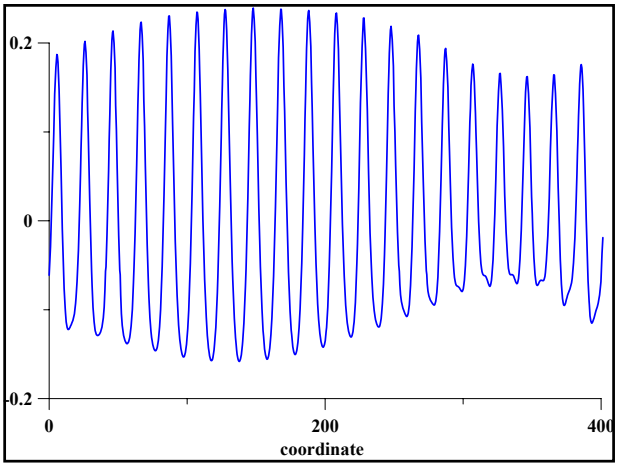
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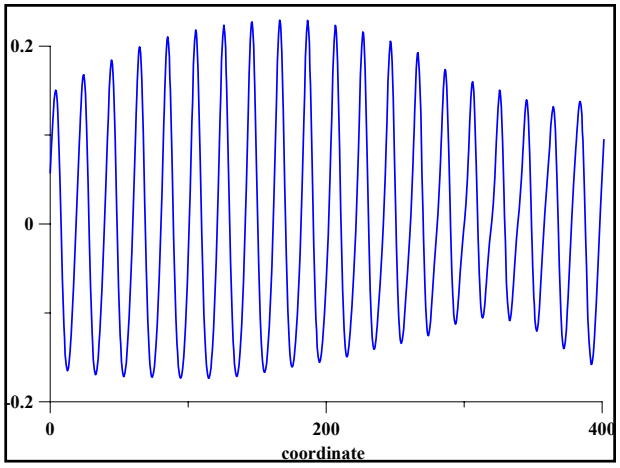
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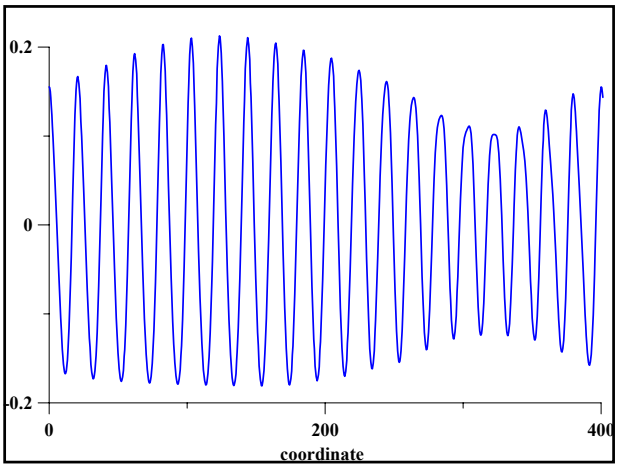
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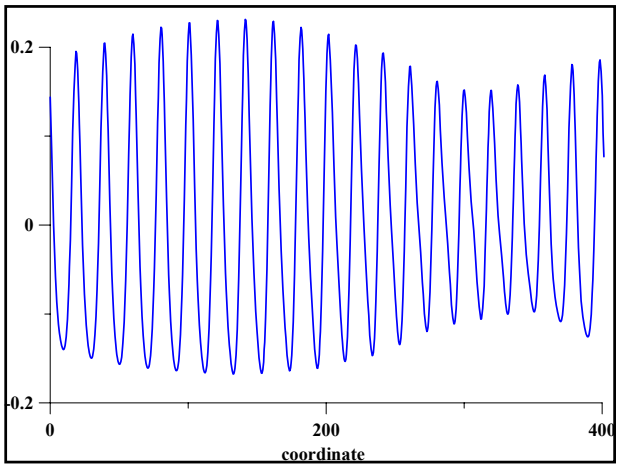
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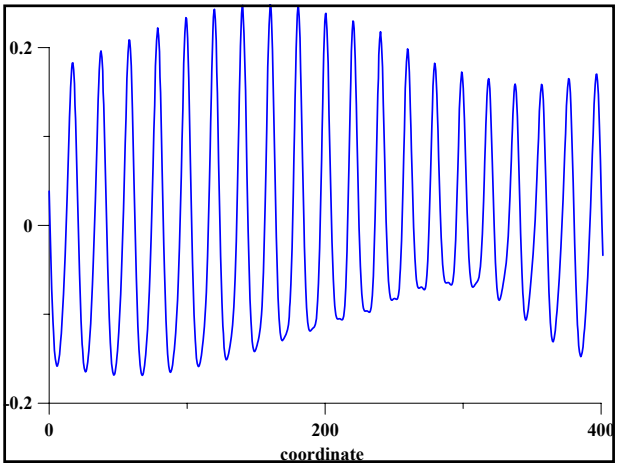
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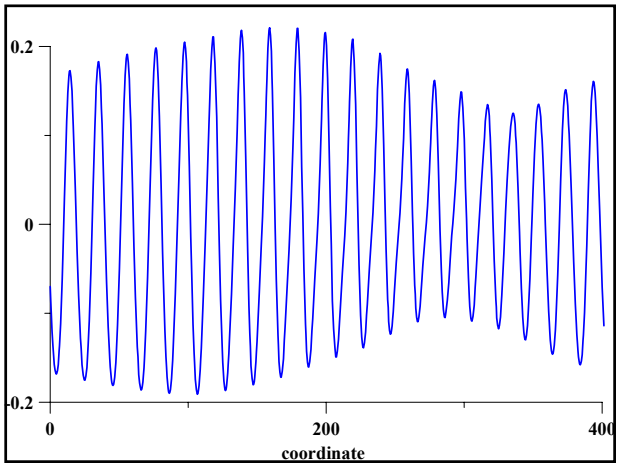
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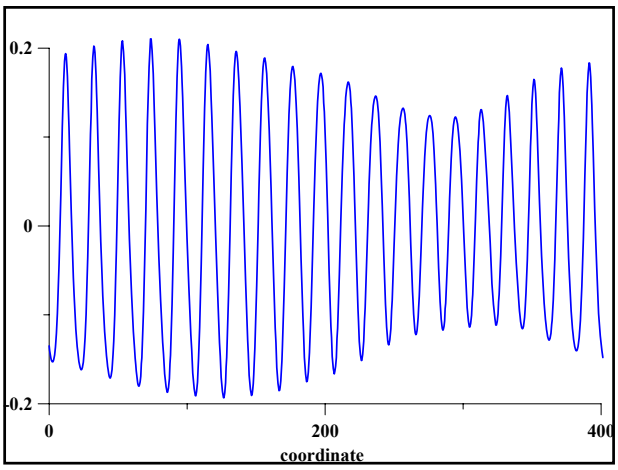
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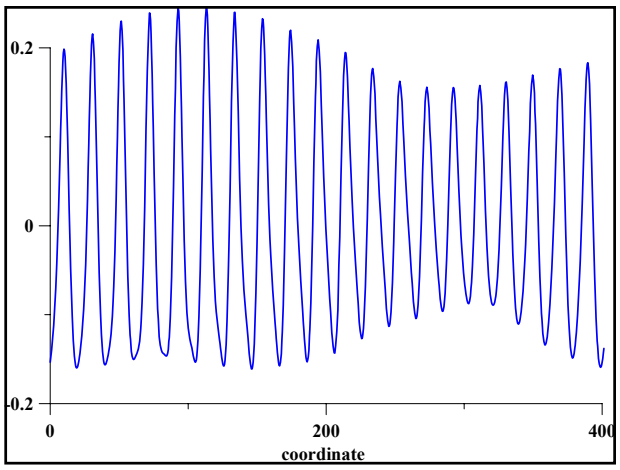
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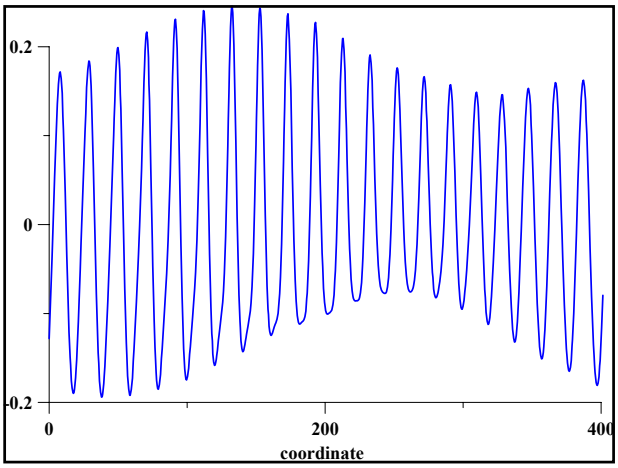
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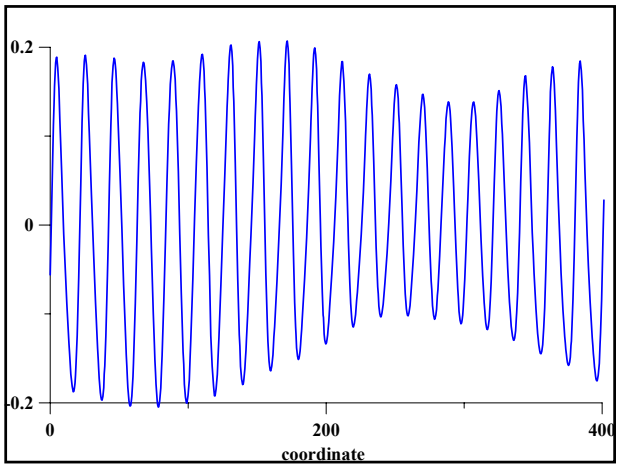
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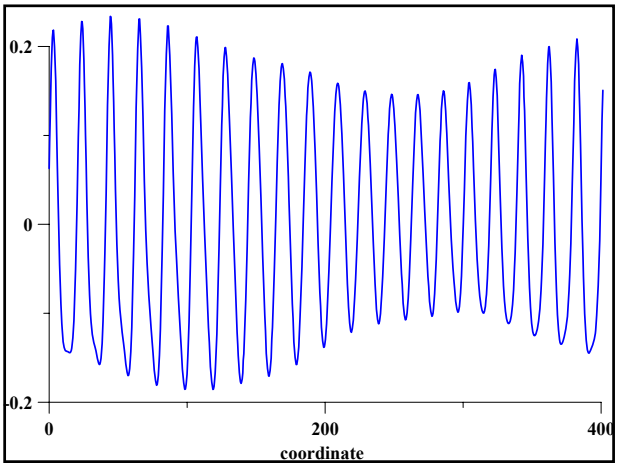
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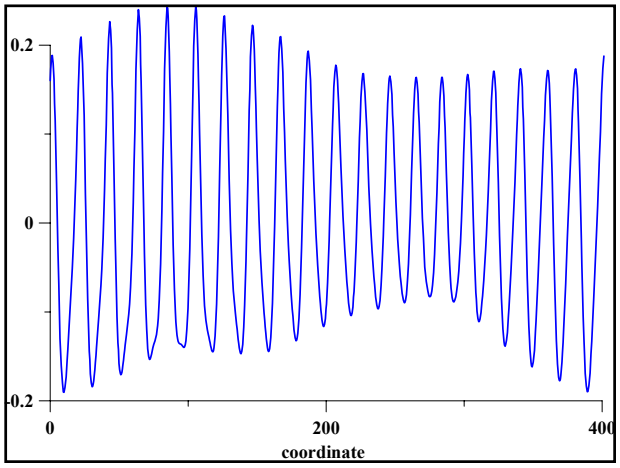
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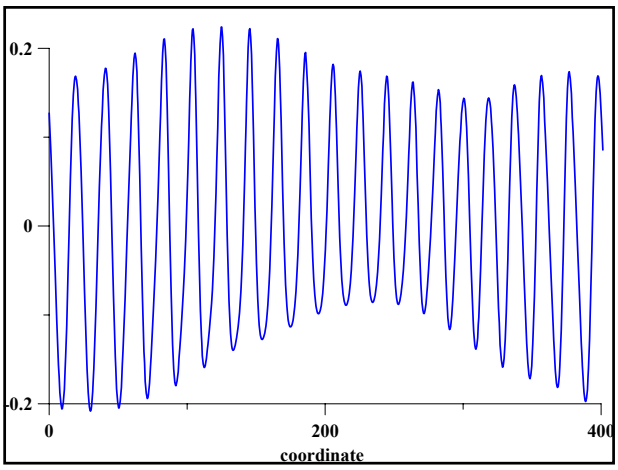
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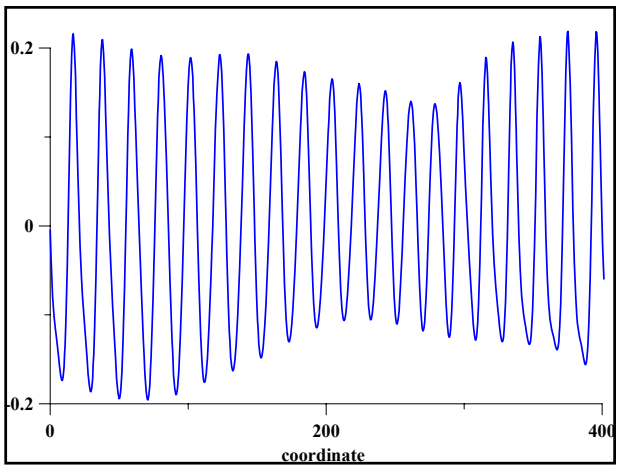
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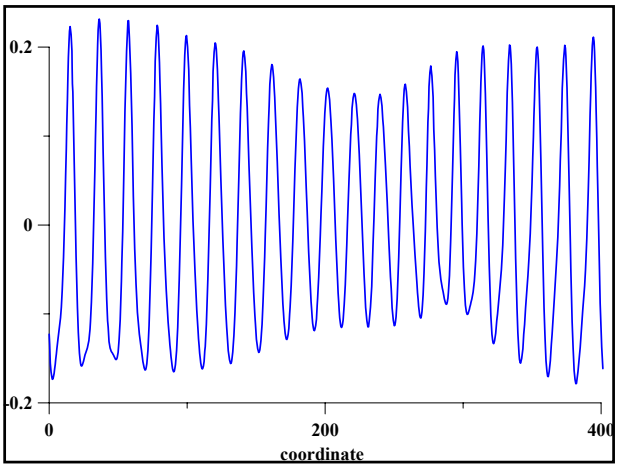
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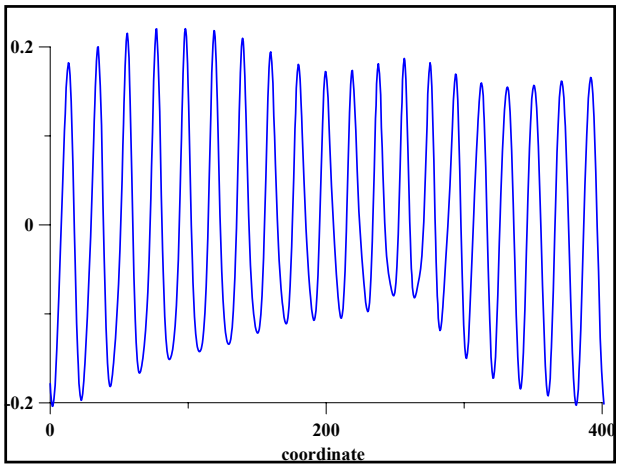
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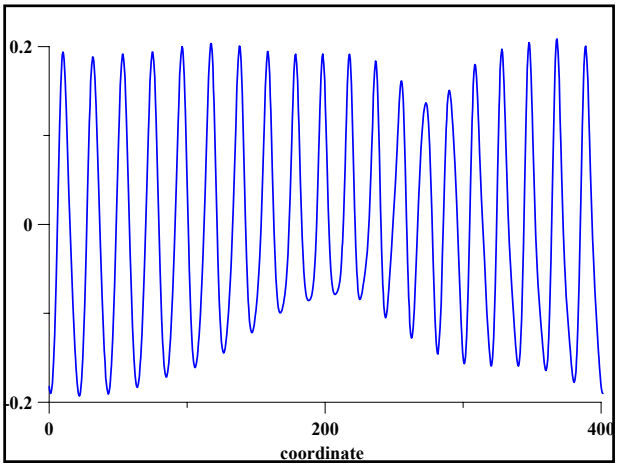
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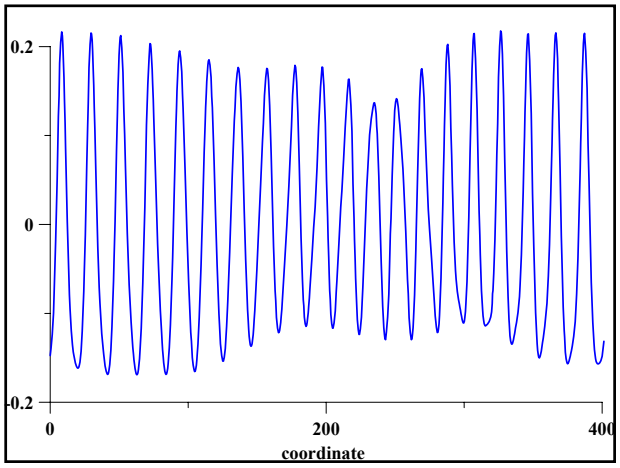
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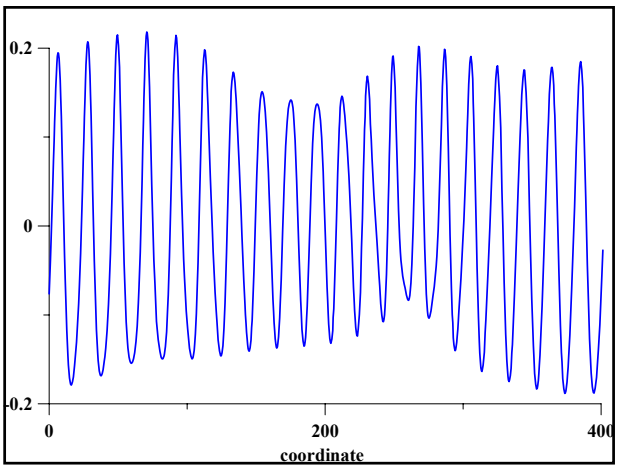
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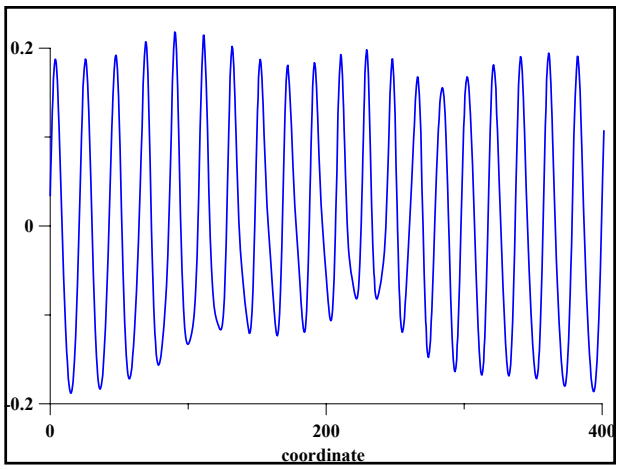
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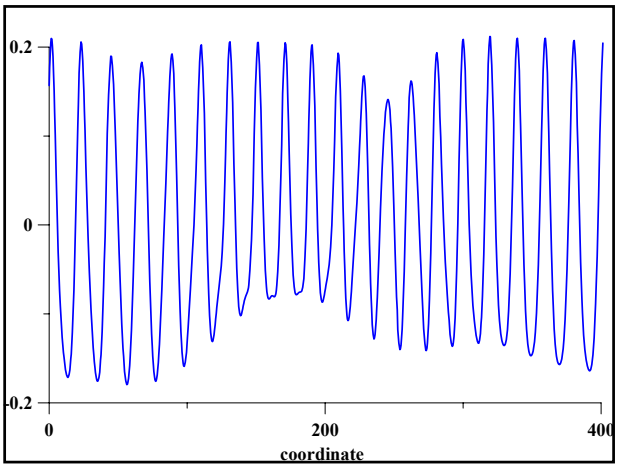
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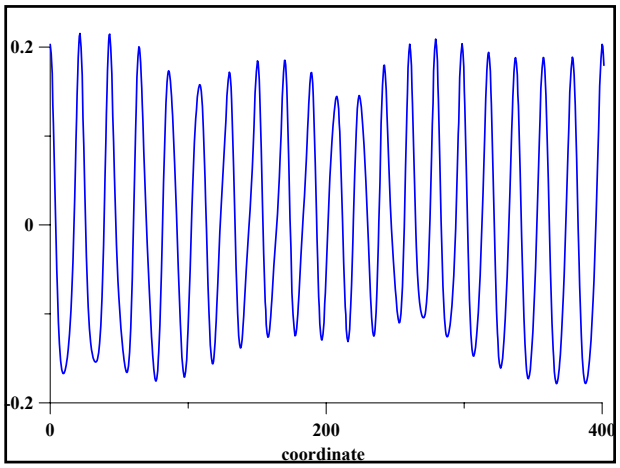
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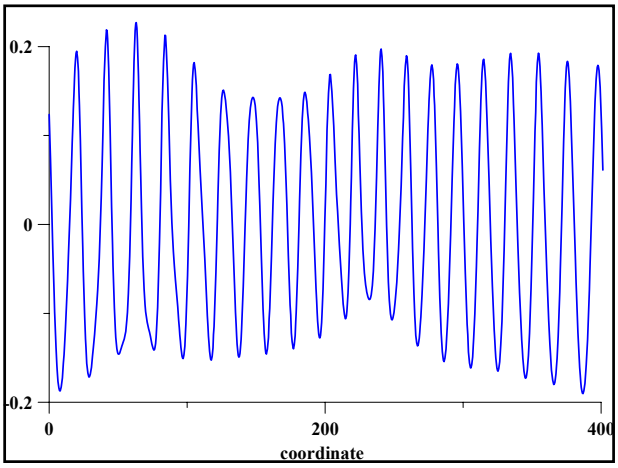
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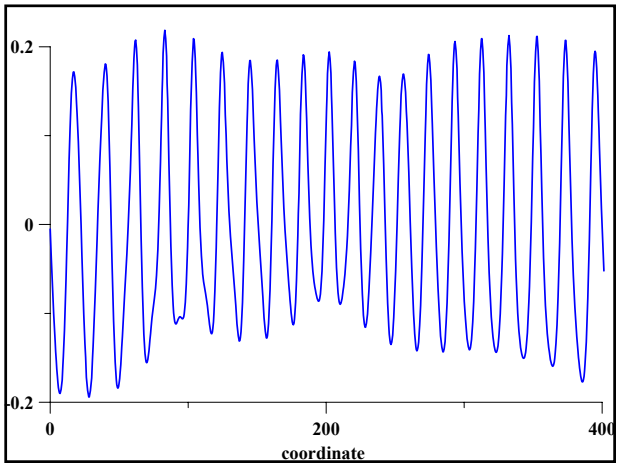
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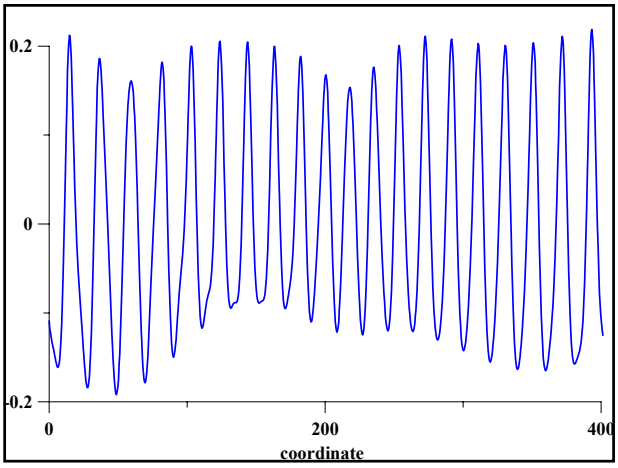
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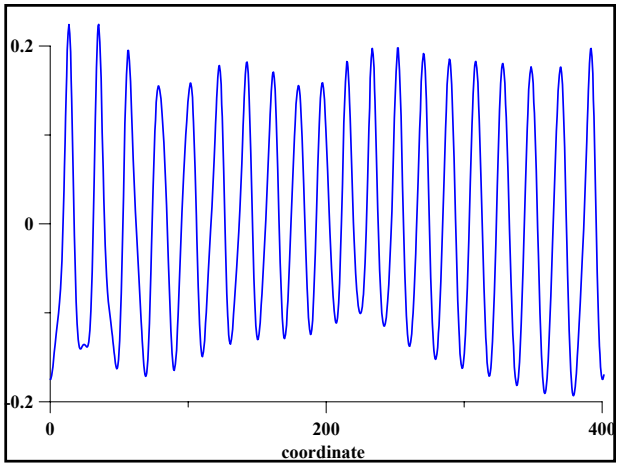
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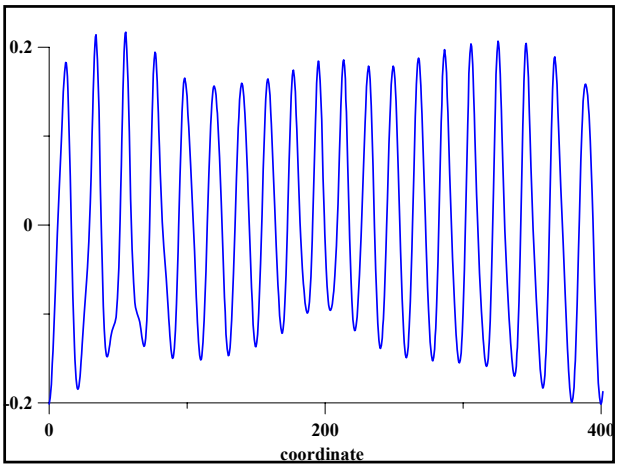
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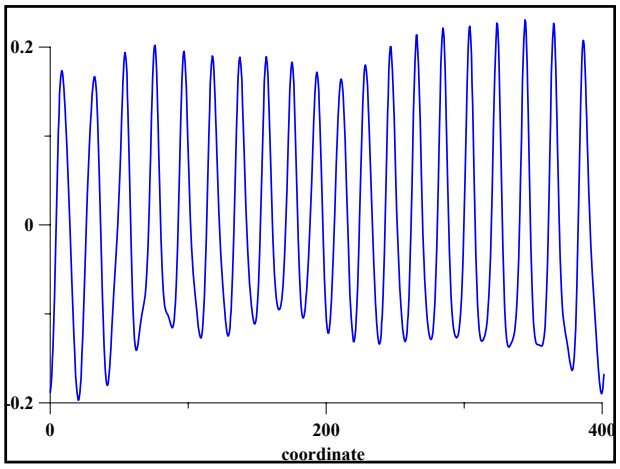
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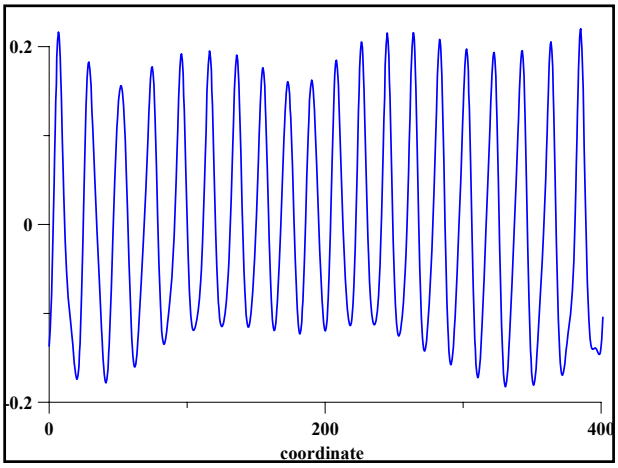
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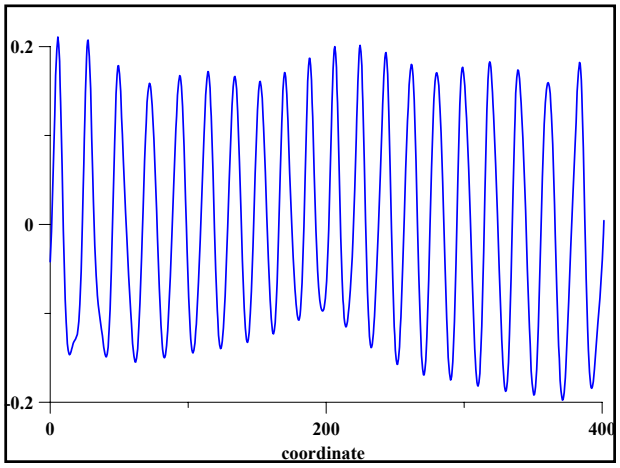
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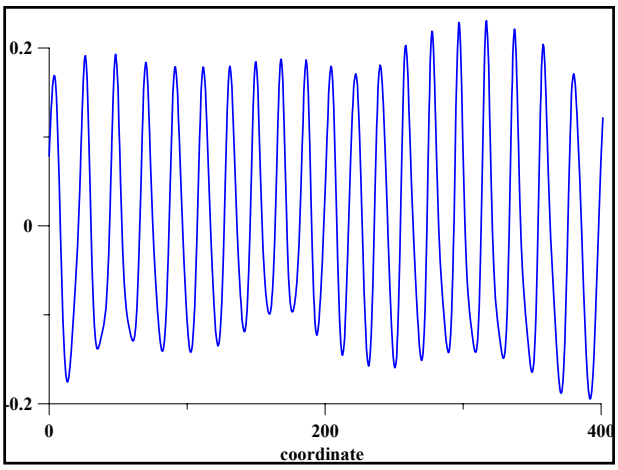
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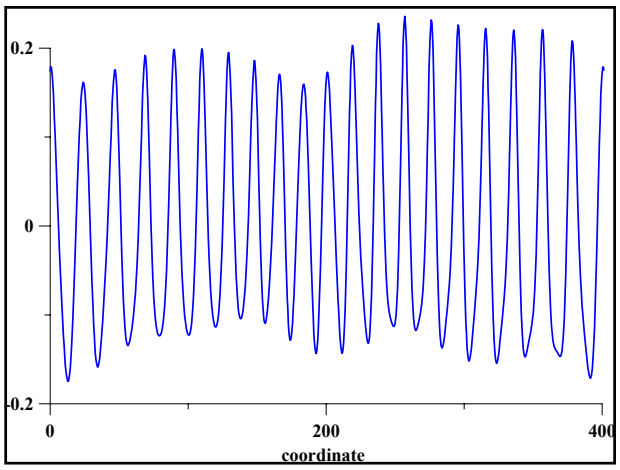
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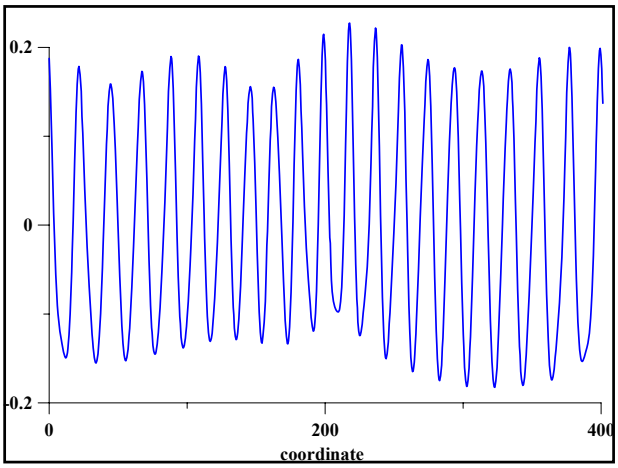
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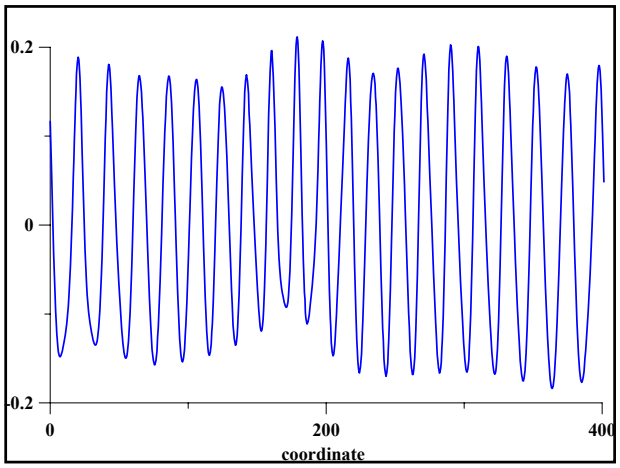
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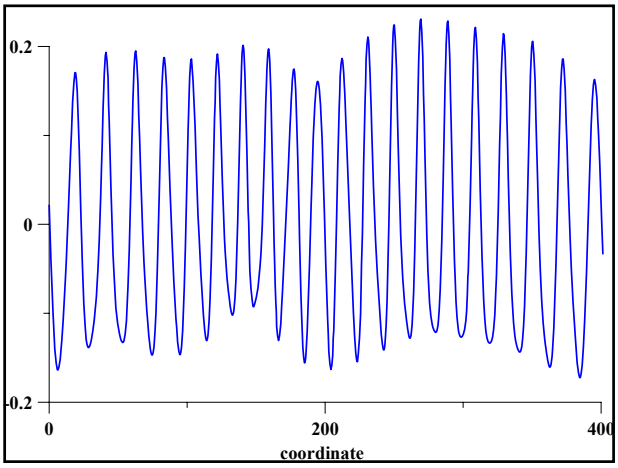
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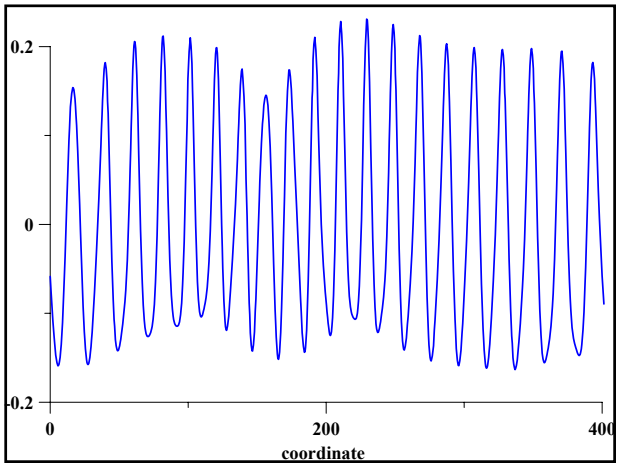
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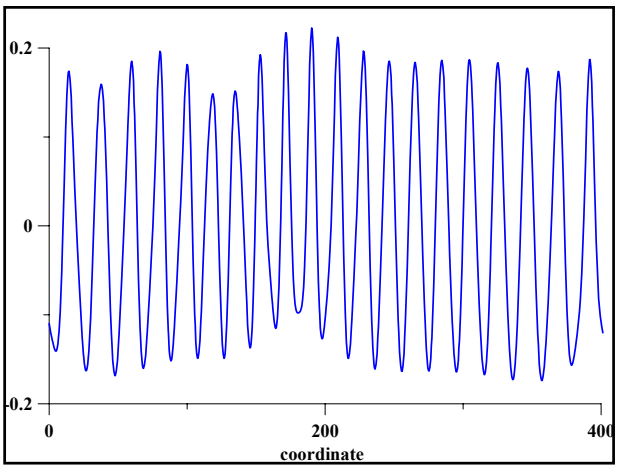
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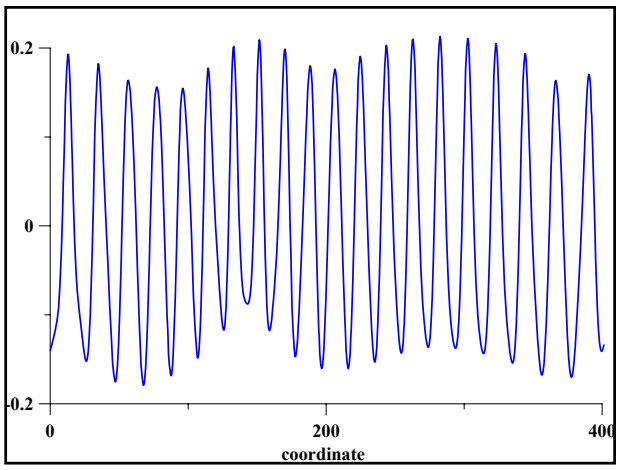
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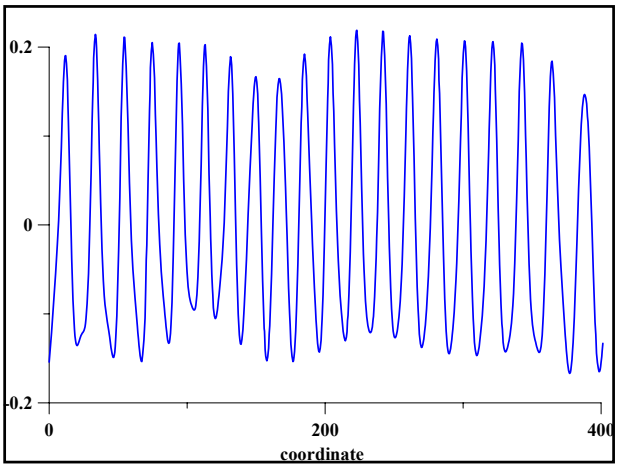
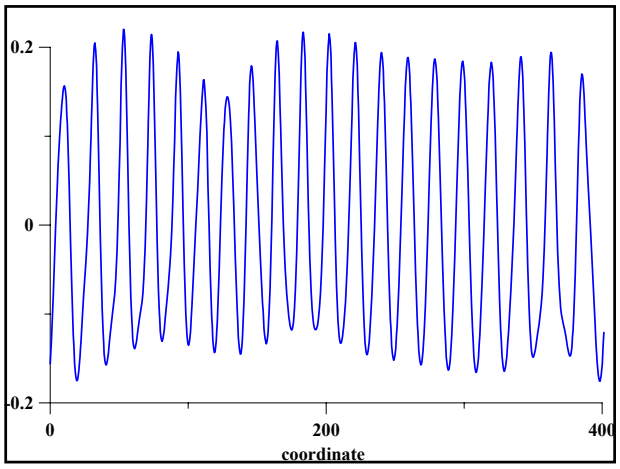
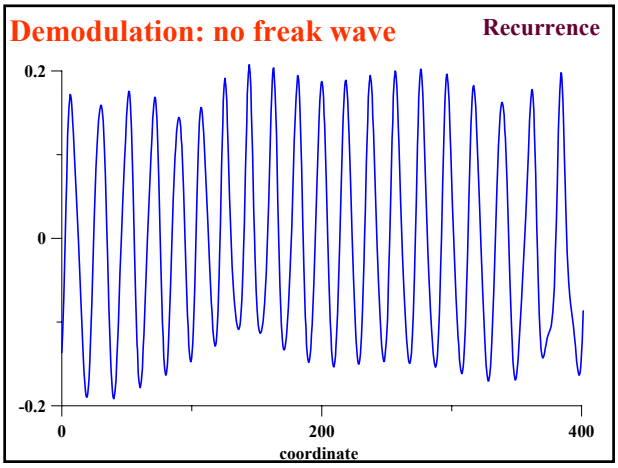
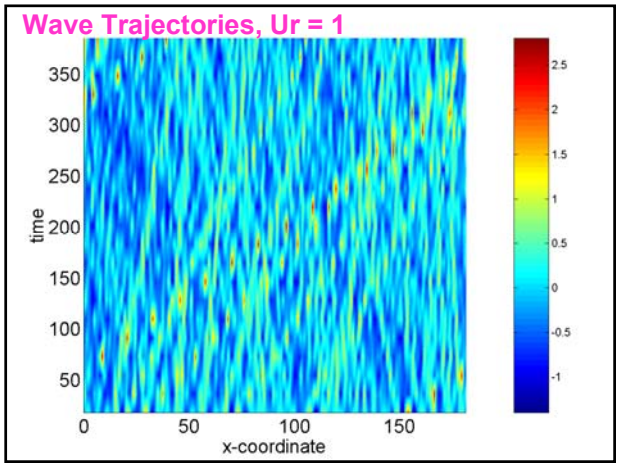
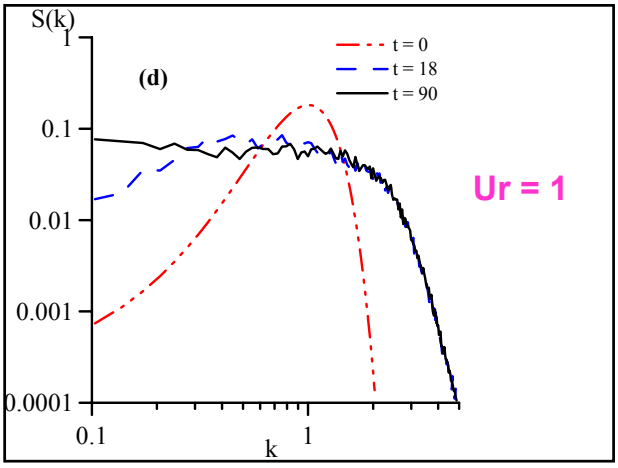






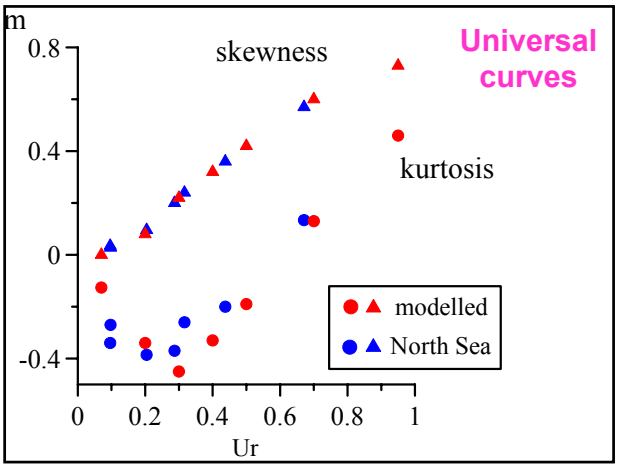


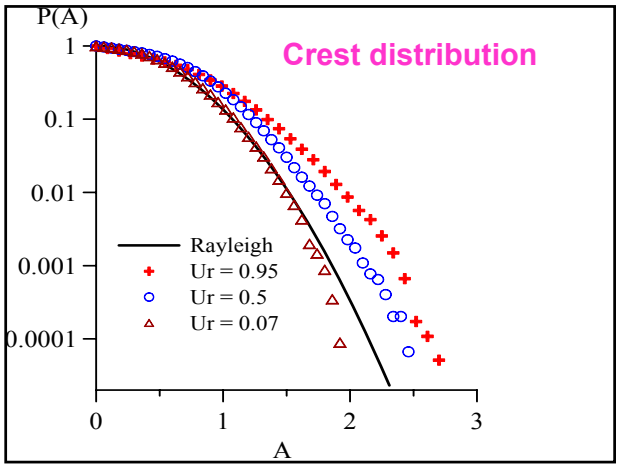


Moment Calculations

skewness $m_3 = \dfrac{M_3}{\sigma_0^3}$

kurtosis $m_4 = \dfrac{M_4}{s_0^4} - 3$



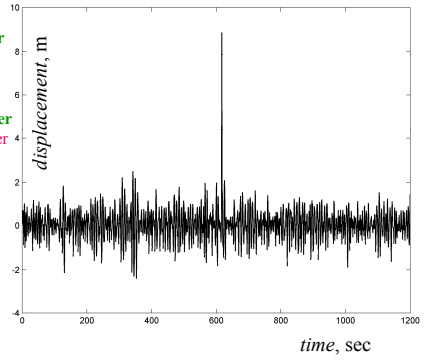


Mechanisms:

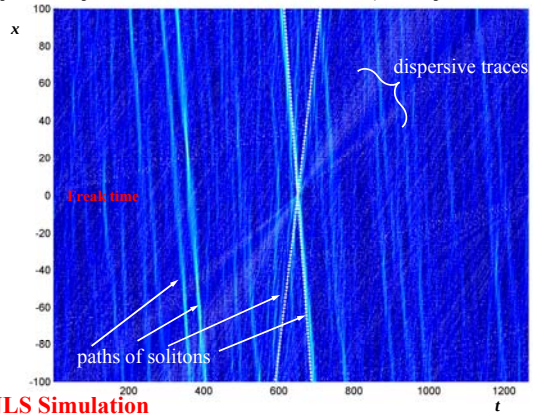
- **Wave – current interaction**
  - wave blocking,
  - random caustics.
- **Wave – bottom interaction**
  - focuses, shallow water only
  - random caustics.
- **"Itself" wave dynamics**
  - temporal-spatial focusing,
  - modulation instability. deep water only

Mean frequency $\omega_0 = 1.05$ rad/sec
Wave period $T_0 = 6$ sec
Mean wavenumber $k_0 = 0.11$ rad/m
Wave length $L_0 = 55.5$ m
Dispersive parameter $k_0 h = 9.63$ deep water
Phase speed $C_{ph} = 9.3$ m/sec
Group speed $C_{gr} = 4.65$ m/sec
Mean amplitude $\langle a \rangle = 0.51$ m
Significant height Hs = 2.6 m
Mean steepness $ka = 0.057$

The record (November 22, 2001)



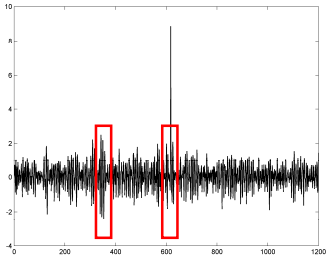
Top-view on space-time field evolution $-100 < x < 100$ (800 m up- and downstream)

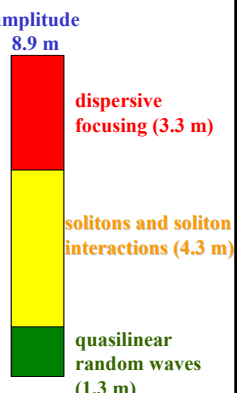


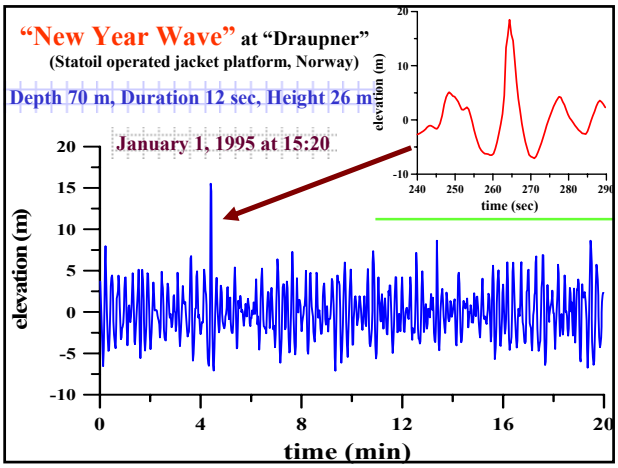
NLS Simulation

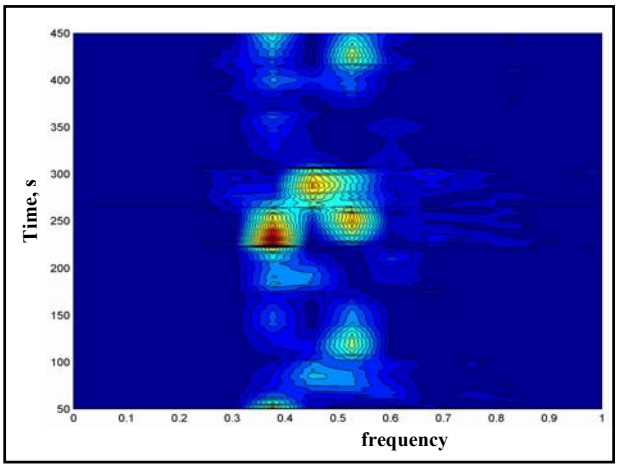
What causes to the freak wave occurrence?

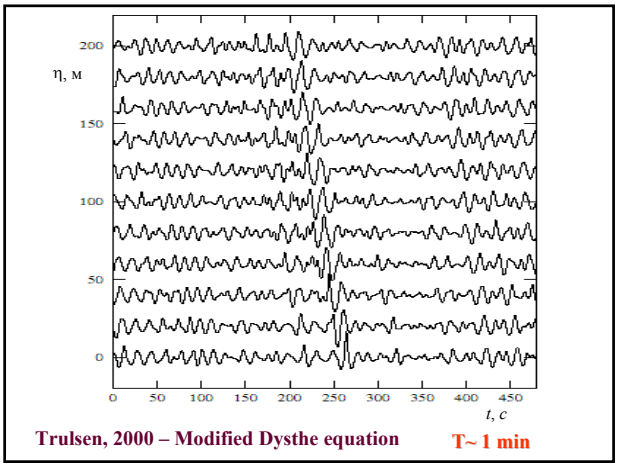
The Black Sea Freak Event - it is:











New Directions in Rogue Wave Study:

1. High-Nonlinear Models (2and 3D)

PRL 99, 044502 (2007) PHYSICAL REVIEW LETTERS week ending 27 JULY 2007

Nonlinear Stage of the Benjamin-Feir Instability: Three-Dimensional Coherent Structures and Rogue Waves

V. P. Ruban*

Pis'ma v ZhETF, vol. 88, iss. 5, pp. 356 – 359 © 2008 September 10

On the Formation of Freak Waves on the Surface of Deep Water

A. I. Dyachenko[1)], V. E. Zakharov

PHYSICS OF FLUIDS 21, 076602 (2009)

Freak waves: Their occurrence and probability

D. Chalikov[a)]

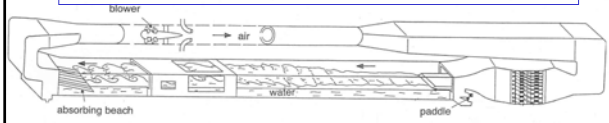
STATISTICAL, NONLINEAR, AND SOFT MATTER PHYSICS

Numerical Simulation of "Limiting" Envelope Solitons of Gravity Waves on Deep Water

A. V. Slunyaev

2a. Forcing Effects: Wind, Friction

Large Air-Sea Interaction Facility at IRPHE, Marseille, France

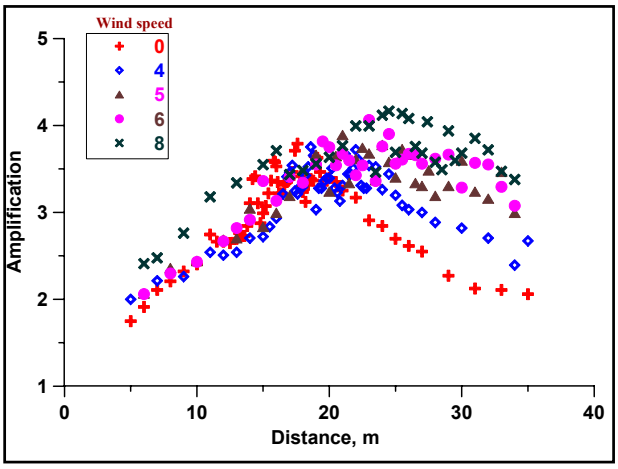


Water tank: 40 m long , 1 m deep, 2.6 m wide

Wind tunnel: 40 m long, 1.6 m high, 3.2 m wide

Water current: +10 cm/s or –10 cm/s

Paddle: 0.5 –2 Hz (regular or random waves)



J. Fluid Mech. (2008), vol. 594, pp. 209–247. © 2008 Cambridge University Press
doi:10.1017/S0022112007009019 Printed in the United Kingdom

Influence of wind on extreme wave events: experimental and numerical approaches

C. KHARIF[1], J.-P. GIOVANANGELI[1], J. TOUBOUL[1], L. GRARE[1] AND E. PELINOVSKY[2]

European Journal of Mechanics B/Fluids 29 (2010) 18–31
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journal homepage: www.elsevier.com/locate/ejmflu

Numerical simulation of interaction between wind and 2D freak waves

S. Yan, Q.W. Ma*

J. Fluid Mech. (2008), vol. 604, pp. 263–296. © 2008 Cambridge University Press
doi:10.1017/S0022112008001171 Printed in the United Kingdom

Can bottom friction suppress 'freak wave' formation?

VIACHESLAV V. VORONOVICH[1], VICTOR I. SHRIRA[2] AND GARETH THOMAS[1]

2b. Forcing Effects: Currents, Swell

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, C12002, doi:10.1029/2004JC002612, 2004

Laboratory measurements of limiting freak waves on currents

Chin H. Wu and Aifeng Yao

J. Fluid Mech. (2009), vol. 637, pp. 267–284. © Cambridge University Press 2009
doi:10.1017/S0022112009990607

Freak wave statistics on collinear currents

KARINA B. HJELMERVIK AND KARSTEN TRULSEN†

J. Fluid Mech. (2010), vol. 650, pp. 57–79. © Cambridge University Press 2010
doi:10.1017/S0022112009993491

Can swell increase the number of freak waves in a wind sea?

ODIN GRAMSTAD AND KARSTEN TRULSEN†

3. Special Experiments and Its Modeling

PHYSICAL REVIEW E 70, 067302 (2004)

Observation of strongly non-Gaussian statistics for random sea surface gravity waves in wave flume experiments

M. Onorato, A. R. Osborne, and M. Serio
Dipartimento di Fisica Generale, Università di Torino, Via Pietro Giuria 1, 10125 Torino, Italy
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C. T. Stansberg

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 114, C01015, doi:10.1029/2008JC005077, 2009

Click Here for Full Article

An experimental study of spatial evolution of statistical parameters in a unidirectional narrow-banded random wavefield

Lev Shemer[1] and Anna Sergeeva[2]

PHYSICS OF FLUIDS 22, 016601 (2010)

Applicability of envelope model equations for simulation of narrow-spectrum unidirectional random wave field evolution: Experimental validation

Lev Shemer,[1,a)] Anna Sergeeva,[2] and Alexey Slunyaev[2]

4. Freaks on the Coast: Rigorous Results

ELSEVIER
European Journal of Mechanics B/Fluids 27 (2008) 409–418

Large-amplitude long wave interaction with a vertical wall

Efim Pelinovsky [a,b,*], Christian Kharif [a], Tatiana Talipova [b]

Coastal Engineering 58 (2011) 94–102
Contents lists available at ScienceDirect
Coastal Engineering
journal homepage: www.elsevier.com/locate/coastaleng

Statistical characteristics of long waves nearshore

Ira Didenkulova [a,b,*], Efim Pelinovsky [b], Anna Sergeeva [b]

5. Action on Ship Design

Fig. 16. Model of the investigated Ro/Ro vessel.

The New Year Wave in a Seakeeping Basin: Generation, Propagation, Kinematics and Dynamics

G. F. Clauss and M. Klein
Ocean Engineering Division, Technical University of Berlin, Germany

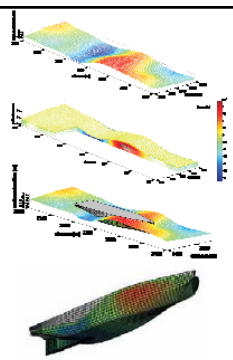

Fig. 15. Irregular short crested sea state (top); slice through the irregular short crested wave field and distribution of the dynamic pressure calculated by adaptive Airy-theory (2nd from top); irregular short crested sea state and pressure distribution on ship hull (3rd from top); Dynamic pressure distribution along a ship hull calculated by adapted Airy-theory (blue indicates negative dynamic pressure, red indicates positive dynamic pressure (below).

6. Applications of Rogue Wave Physics

COMMISSION OF THE EUROPEAN COMMUNITIES

RESEARCH DIRECTORATE-GENERAL

SP1-Cooperation

Collaborative project

Small or medium-scale focused research project

FP7-SST-2008-RTD-1

Grant Agreement Number 234175

EXTREME SEAS

Design for Ship Safety in Extreme Seas

SCP8-GA-2009-234175

1. Instituto Superior Técnico
2. Germanischer Lloyd AG
3. Technical University of Berlin
4. Meteorological Institute
5. Universita di Torino
6. Institute of Applied Physics
7. Canal de Experiencias Hidrodinamicas de El Pardo
8. MEYER WERFT GmbH
9. Estaleiros Navais Viana do Castelo SA
10. University Duisburg-Essen
11. Det Norske Veritas AS

7. Rogue Waves in Nature: plasma, optics, geophysics, etc

nature news

Published online 12 December 2007 | Nature | doi:10.1038/news.2007.360

News

Rogue waves made of light

Freak waves in an optical system might help to explain those at sea.

Philip Ball

Gigantic 'rogue' waves that swallow ships have been brought into the laboratory. No one knows exactly how they form in the oceans, but a team at the University of California, Los Angeles, has made similar freak events in light[1]. The researchers say that their work should help to explain this terrifying maritime phenomenon.

Rogue waves were originally thought to be a myth. Lone waves tens of metres high had been described in sailors' anecdotes, but it wasn't until the mid-1990s that they were documented convincingly. One such wave struck an oil platform in the North Sea in 1995, another was photographed in 1993 in the Bay of Biscay.

There have been more sightings since. In 2001, for example, a passenger ship in the South Atlantic was hit by a wave about 30 metres high. Yet conventional theories of ocean waves predict that these monsters should be so rare that they would effectively never be seen.

It's now recognized that the oceans defy those theories. Most waves are small; the bigger the wave, the rarer it is. But there is still an anomalously high number of extremely big waves. It isn't clear why.

Various explanations have been proposed, invoking unusual wave-focusing effects or freak winds. A key feature of rogue waves is that they stay as sharp peaks as they move, making them look like 'walls of water'. This is a similar to 'self-reinforcing solitary waves' or solitons, which can sweep over large distances without dispersing, keeping the same size and shape.

Solitons were first observed in a Scottish canal in the nineteenth century. They are now well studied in light as well as in water. So Daniel Solli and his colleagues wondered whether they could use the techniques known to generate optical solitons to make rogue waves in light.

Waves of light: you can get freak peaks in optical systems.

Getty

Eur. Phys. J. Special Topics 185, 1–4 (2010)
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DOI: 10.1140/epjst/e2010-01233-0

THE EUROPEAN PHYSICAL JOURNAL SPECIAL TOPICS

Editorial

Editorial – Introductory remarks on "Discussion & Debate: Rogue Waves – Towards a Unifying Concept?"

N. Akhmediev[1,a] and E. Pelinovsky[2,b]

Rogue internal waves in the ocean: Long wave model

R. Grimshaw[1,a], E. Pelinovsky[2], T. Taipova[2], and A. Sergeeva[2]

Rogue edge waves in the ocean

E. Pelinovsky[1,2,a], O. Polukhina[3], and A. Kurkin[2]

Freak waves in laboratory and space plasmas

Freak waves in plasmas

M.S. Ruderman[a]

Extreme events in optics: Challenges of the MANUREVA project

J.M. Dudley[1,a], C. Finot[2], G. Millot[2], J. Garnier[3], G. Genty[4], D. Agafontsev[5], and F. Dias[5]

Rogue waves in superfluid helium

V.B. Efimov[1,2,a], A.N. Ganshin[1,b], G.V. Kolmakov[1,3,c], P.V.E. McClintock[1,d], and L.P. Mezhov-Deglin[2,e]

Vector rogue waves in binary mixtures of Bose-Einstein condensates

Yu.V. Bludov[1,a], V.V. Konotop[2,b], and N. Akhmediev[3,c]

You are kindly invited to participate in the session NH5.2/NP7.4/OS5.5 - "Extreme Sea Waves" at the General Assembly of the EUROPEAN GEOSCIENCES UNION to be held in Vienna, Austria, 3-8 April 2011.

The aim of the session is to describe all aspects of the large-amplitude wave phenomenon in the ocean as the freak, rogue and storm waves: dynamical and statistical theories, observations and modelling, numerical simulations in the framework of approximate theories as well as full nonlinear equations. Special attention will be paid to the description of the wave breaking process, and also large-amplitude wave interaction with coastal structures. The rogue wave phenomenon of any physical nature will be discussed also.

http://meetings.copernicus.org/egu2011/

Deadline for receipt of abstracts : 10 January 2011

Conveners:

Efim Pelinovsky, Christian Kharif and Alexey Slunyaev

Natural Hazards and Earth System Sciences

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NHESS - Special Issue - Extreme and rogue waves

Special Issues

NHESS - Special Issue

Extreme and rogue waves
Editor(s): E. Pelinovsky and C. Kharif

Freak waves of different types in the coastal zone of the Baltic Sea 30 Sep 2010
I. Didenkulova and C. Anderson
Nat. Hazards Earth Syst. Sci., 10, 2021-2029, 2010
Abstract Full Article (PDF, 520 KB)

Brief communication "What do we know about freaque waves in the ocean and lakes and how do we know it?" 22 Oct 2010
P. C. Liu, C. H. Wu, A. J. Bechle, K. R. MacHutchon, and H. S. Chen
Nat. Hazards Earth Syst. Sci., 10, 2191-2196, 2010
Abstract Full Article (PDF, 1101 KB)

MAX-PLANCK-INSTITUT FÜR PHYSIK KOMPLEXER SYSTEME
VISITORS PROGRAM
DR. SERGEJ FLACH

Rogue Waves 2011

1-8 November, 2011, Dresden, Germany

Chairmen:
Nail Akhmediev, Canberra, Australia
Allan Newell, Arisona, USA
Efim Pelinovsky, Nizhny Novgorod, Russia

Conclusions for Ocean:

Freak Wave Phenomenon is a subject of Modern Physics and Engineering

Several mechanisms result to freak wave appearance

Tasks:

Statistics of freak waves: physics and geography

Moral of the Lecture:

Never underestimate

the unpredictability

of rough seas