

## In Search of Realism on the Study of Freaque Ocean Waves

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### ABSTRACT

In this presentation I expect to discuss the lesser known or underexplored aspects of the phenomenon of freaque ocean waves, what realities that might exist and what challenges we are facing. The current study of freaque waves has been an active research field over the last two decades or more. There have been significant advancements especially in connection with the study of nonlinear physics. Upon exploring the tangibility of what we do or do not know, there are still unrelenting challenges remain to be delved into.

Keywords: ocean waves; freaque ocean waves

### 1. Introduction

Freaque wave has been in existence probably as long as the world's oceans are in existence. But it was not until Draper (1964) [1] first calling it a "freak wave" did its existence ever being academically acknowledged. And it took still over another two decades when Draupner platform in the North Sea recorded the famed wave profile on 1995 New Year 's Day (Haver, 2004) [2] that everyone immediately recognized as the shape of a freaque wave did the academic world beginning to embark on freaque wave studies.

Dias et al. (2010) [3] made an interesting observation regarding freaque waves: "once part of the folklore, they now made the news each time an observation is made." Indeed we have probably heard more media reports on freaque wave cases in the first decade of the 21st century than in all of the 20th century years combined. But a curious phenomenon crops up here: out of all the freaque wave encounters that were reported, do we really have a clear notion as to what was happening out there? Most likely we know something

unexpected occurred but not much else. So, in regard to freaque waves that are happening in the ocean and lakes every day, we think there is more that we do not know about them than what we do know. One of Confucius' analects says "Know what you do know, and recognize what you do not know, that then is true knowledge" may be applicable here. In this paper, we present an exploration on the aspects of the freaque waves that we do not seem to have clear answers for as our unrelenting challenges. Of course these are personal opinions; presumably they will not be shared by all. Some may consider these issues uninteresting or even unscientific or trivial, but they are the topics that we do not know and should not be remain obscured.

### 2. Freaque waves -- the phenomenon

Let's start with some nomenclature here. The term "freaque wave" is a portmanteau word that blends the two commonly used words "freak" and "rogue" in reference to "freak or rogue waves" frequently used. Actually, there are also terms like killer waves, extreme waves, monster waves, giant waves, abnormal waves,

sneaker or sleeper waves being used. We wish for “freak waves” to represent all of the above except extreme waves. Because the main feature of the phenomenon is unexpectedness, whereas every wave recording has a local maximum or extreme, extreme waves really do not explicitly belong to the “unexpectedness” category. At any rate, this usage merely represents a personal preference for convenience.

### 3. What do we know?

Three years ago Liu et al. (2010) [4] first asked the question: “What do we know about freak waves in the ocean and lakes and how do we know it?” There they made an objective examination of our present state of knowledge on freak waves in the ocean and lakes from three separate perspectives:

- testimonial – from eyewitness accounts of actual encounters;
- empirical – from available in-situ wave measurements;
- conjectural – from academic theoretical formulations.

Thereby, they subjectively surmised that “we do not know very much about freak waves in the ocean and lakes!” Clearly there is really no surprise there. The three perspectives are nature settings where our basic knowledge bases are summarily developed from. However, saying we do not know very much is too broad a statement to be of substance. Here we hope that we can provide some specifics!

### 4. What do we not know?

- Do we have a viable definition for the phenomena yet?
- Does the well-known plot of the Draupner platform 1995 New Year’s Day wave data truly represent the same kind of freak waves widely reported to have been occurring in the ocean and lakes that caused disasters and damages?

- Are there different kinds of freak waves?
- How often does a freak wave occur?
- Is there a life cycle for freak wave occurrence?
- Do freak waves ever making loud noises?
- What is the role of wave breaking in connection with freak wave occurrence?
- Are freak waves predictable?
- How to realistically measure freak waves?

### 5. What are the theoretical view points?

We have so far been concerned mainly from observational viewpoints. The major advancements since freak waves became a favorite topic of the general public and news media has been mostly in the theoretical arena. As Akhmediev et al. (2009)[6] pointed out; in the title of their manuscript “Waves that appear from nowhere and disappear without a trace” can be applied to two objects: the rogue waves in the ocean and rational solutions of the nonlinear Schrodinger equation (NLSE). Indeed solving NLSE has been the backbone of the modern freak wave study. The only real issue is the existence of the Draupner wave profile, nothing else seems to matter.

In 2010, the editors of the European Physical Journal conceived an issue of Special Topics (Ruban, et al. 2010)[15] by asking a selected special group of prominent physicists for their opinion on rogue waves. The editors posed these questions:

1. Is the phenomenon of “rogue waves” linear or nonlinear?
2. What is the onset of appearance of “rogue wave”? Is it the phenomenon related to modulation instability?
3. What is the spectral content of “rogue waves”?
4. How important is the distribution of wave amplitudes in registering rogue waves? For example, observations in optics pay special attention to the function of distribution.
5. Do you consider some other questions to be more important than those listed above?

This Special Topics issue has gathered opinions from 18 of the world's leading nonlinear physicists, and has provided very interesting and educational discussion and debates. They are clearly not really concerned about observations. These theoreticians in their pursuit brought out a whole body of knowledge of their own. But for a non-theoretical freaque wave aficionado, an immediate question that comes to mind is: where is the ocean?

Judging from the question about spectral contents, it appears that most of these theoreticians' concerns are generally connected to processes at a single point. Indeed it seems the whole field of freaque wave research in nonlinear physics has stemmed from the popularization of the Draupner wave data – a conventional wave measurement at a single-point location on the Statoil's Draupner Platform in the North Sea. So, while observations and measurements can bring different kinds of freaque waves, for theoreticians, the Draupner wave alone would seem to be sufficient.

## 6. Discussion

The editorial of the 2012 New Year issue of New Scientist Magazine has a very interesting byline: "Next year let's deal with world as it is, not as we would like it to be." It seems the whole science establishment, academic and others alike can benefit from this advice. When we are preoccupied in solving intriguing complicated formulas, the real world can sometimes become a minor inconvenience!

Furthermore, we have repeatedly alluded to the need of 3-D spatial wave measurements, what difference do they make?

Here are some thoughts between 1-D and 3-D spatial fields:

- Crests or troughs occur at 1-D are not necessarily the crests or troughs in the 4-D spatial field.

- A maximum wave height in 1-D is not necessarily the maximum wave height in 4-D spatial wave field.
- If there is no freaque wave found in the 1-D data it does not mean there is no freaque wave in the 4-D spatial wave field.
- As there can be clear defined zero level in 1-D so that we can talk about zero-crossing cases. There is no equivalence in the 4-D spatial field.
- It is possible to readily sensing wave breaking effects in 4-D, but not in the 1-D wave field.

So in reality we cannot expect true processes of ocean waves to emerge from exploring waves and freaque waves with only the 1-D wave field and with waves only measured from a single point location.

## 7. Concluding Remarks

A well-known quote that was attributed to the 18th century mathematician, Pierre-Simon Laplace (1749-1827), is: "What we know is not much. What we do not know is immense." (*Ce que nous connaissons est peu de chose; ce que nous ignorons est immense.*) It seems this quote is very applicable to confront the challenges on our study on freaque waves. Now that we have managed to examine both what we DO know and what we DO NOT know on freaque waves, we must admit that we have immense admiration for Laplace' sagacious observations. What was also interesting is that in both cases, we have invariably arrived at the same conclusion– we need more intensive and modernized spatial ocean wave measurement! The destitution of relevant wave measurement for freaque waves study is certainly nothing new or trivial. Nonlinear physics studies have greatly contributed to the development, advancement, and popularization of our modern freaque wave studies. But the conventional wave measurement system is still relying on the last conceptual advancement, vintage 1945. A new conceptualization is certainly long overdue. Yes, we are over a decade into 21st century; the Draupner wave form that was discovered at the end of last century

cannot sustain our nonlinear physics research indefinitely. There is so much we still do not know and should not be pretending that they don't exist. We should be at least contemplating about something like spatial wave measurement by now to confront the unrelenting challenges we face!

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