The genesis of **Negative Energy Waves** in hydrodynamics

Santu Das

**ABSTRACT: N**egative **E**nergy **W**aves (**NEW**) are such type of waves, generation of which in the system reduces the total energy of the system. Consequently, the removal of energy from such a wave results in the growth of it and introduces instability in the system. While this particular nature of the wave is very prominent in waves in electron beams [1] and plasma [2], a similar concept in hydrodynamics is not much popular. Even in some early works of physics, it was opined that a possible generation of NEW in fluid mechanics is out of the question. Although early works on hydrodynamic instabilities can be found in as early as back in the nineteenth century [3] (although the term NEW is not explicitly mentioned), much of the theory's advancements are carried out in the latter half of the twentieth century. The problems in other aspects of physics and hydrodynamics may look miles apart at first glance, but they have quite many similarities with electrodynamics. The primary reason for the hydrodynamic part, not gaining much popularity is due to complications in theory. While using one-dimensional beam theory, much physical interpretation can be inferred in electrodynamics, the same can not be induced in the hydrodynamic problems as they are two-dimensional, and waves can possibly change its velocity abruptly.

In this talk, we shall concentrate primarily on the generation of NEW instead of indulging ourselves in the generation of instability in the flow, which is primarily a non-linear process. However, we shall briefly go through one or two such cases of instabilities whenever necessary. The wave energy density and wave energy flux, two crucial properties responsible for the generation of NEW, will be derived using averaged variational principle [4, 5]. The criteria for the generation of NEW will follow after applying linearisation. The following physical systems will be considered as examples to show the generation of NEW:

1. Flow past elastic membrane.
2. Movement of thin layer above a resting fluid.
3. Internal waves in a layered fluid.

The talk will be concluded with a few recent works on NEW that will include

1. Capillary-gravity waves
2. Flexural-gravity waves
3. Shear flow (with having both free surface and elastic cover)

## REFERENCE

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