Contribution ID: **19** Type: **Oral presentation**

Use of a mobile phone and readily available objects for the study of oscillations and internal gravity waves in a stratified fluid

We propose a variant of the well-known Cartesian Diver experiment, where the diver floats in a fluid stratified in density obtained from the dissolution over time of a quantity of coarse salt placed at the bottom of the container.
In contrast to the original version of the experiment, the diver can stop in a stable equilibrium position within the fluid, at the height where the surrounding density matches its own. By varying the applied pressure, the diver's density changes and it moves to a different height accordingly. When a sudden pressure pulse is applied, the diver, pushed off its temporary equilibrium position, starts oscillating due to a restoring force. The frequency of oscillation, known as Brunt–Väisälä frequency, depends on the density gradient. Therefore, by changing the pressure on the container, students can span different heights and density gradients and observe their evolution in time with a single non-invasive experiment. Other interesting phenomena occur, such as the propagation of internal gravity waves typical of stratified fluids when a portion of them is displaced transmitting its motion to the surrounding fluid. These phenomena typically occur in the atmosphere and in the stars and are difficult to visualize as they only produce refractive index variations within the fluid. One trick to make them visible is to put in suspension small fragments of a material of appropriate density, which localize in a fluid layer and oscillate when the gravity waves pass. Therefore, with this simple experiment that students can project and realize by themselves with easy-to-find objects and by following all the steps, it is possible to introduce them to complex phenomena of general interest.
Thanks to the use of a mobile phone and of simple free educational programs, which allow recording the diver oscillations, plotting and fitting the data, students can perform quantitative analysis of the results, and therefore enhance their understanding of the physics issues.

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Session Classification: Oral presentations

Track Classification: Modern equipment and technology to improve Physics Teaching and Learning.