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Les courant moyens - quel rôle jouent-ils dans l'effet Doppler ?

In the ocean, internal waves commonly occur together with other, large-scale (mean) flows. How are the wave properties affected by such mean flows? In the oceanographic literature, mean flows are often said to create a “Doppler shift”. It has passed unnoticed, however, that the term “Doppler shift” is being employed in an ambiguous way. Upon closer examination, it appears that two quite distinct concepts of “Doppler shifts” feature in the literature; they are sometimes conflated, resulting in erroneous interpretations. One concept refers to the difference in frequencies measured by two observers, one at a fixed position and one moving with the mean flow—here referred to as “quasi-Doppler shifts.” The other concept is the one used in physics, where the frequency measured by an observer is compared to that of the source. In the latter sense, Doppler shifts occur only if the source and observer move with respect to each other; a steady mean flow alone cannot create a Doppler shift. This talk rehashes the classical theory to straighten out some misconceptions. It is also discussed how wave dispersion affects the classical relations and their application.

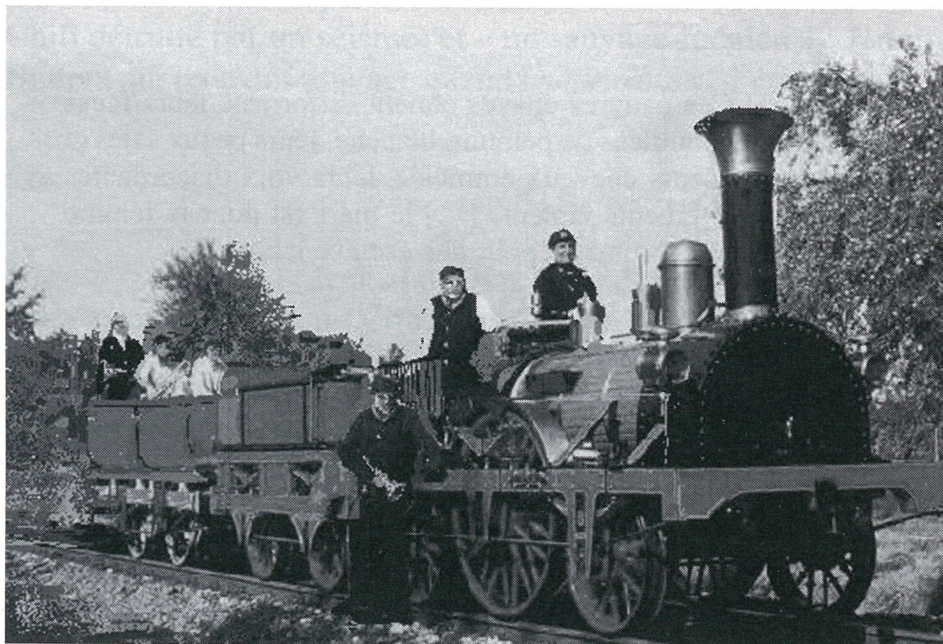


Figure 1: The theory of Doppler shifts is basically 19th century physics (in particular, by the late 19th century it was already textbook knowledge that mean flows do not create Doppler shifts). The first experiment to test Doppler's theory was carried out by Buys Ballot at a newly built railway near Utrecht in 1845. He had musicians, standing on a moving train, playing tones on a trumpet, and other musicians standing along the railway to note the change in pitch at the passage of the train. The result was a triumphant confirmation of Doppler's theory. In the context of this experiment, the point of this talk is to reiterate that a breeze of wind would never create a Doppler shift - only a relative movement of train and observer can. (Figure reproduced from N. Witkowski, Une histoire sentimentale des sciences, Seuil 2003 – origin of the photograph not stated.)

1. T. Gerkema, L.R.M. Maas & H. Van Haren, 2013: A note on the role of mean flows in Doppler-shifted frequencies. *J. Phys. Oceanogr.*, 43 (2), 432-441.