letters

Relativity's forgotten figure

Your excellent May issue on the Michelson–Morley centennial reminded me that this year is also the centennial of a theoretical paper that is largely forgotten, but has a certain role in the history of the theory of relativity even though it has no documented impact on the actual historical development. It is a paper by Waldemar Voigt on the theory of the Doppler effect, which appeared in 1887 in the *Göttinger Nachrichten*.[1] Voigt showed that from any solution of the wave equation that represents a disturbance propagating from a source at rest in the privileged frame of reference (ether or atmosphere), one can construct a new solution in which the source is in uniform motion relative to that frame by making use of the invariance of the wave equation now known as the Lorentz transformation. He showed that the result is in agreement with Christian Doppler's principles.

Voigt, who was well known for his fundamental contributions to the mechanics and optics of crystals, was reputedly disappointed that his note got little recognition. Only in Wolfgang Pauli's monumental work on the theory of relativity, which appeared in the *Enzyklopädie der Mathematischen Wissenschaften* in 1921 (two years after Voigt's death), is the work of Voigt mentioned.[2] It is the first reference, albeit with the comment, "Diese Bemerkung blieb jedoch vollständig unbeachtet [This remark, however, remained completely unnoticed]."

Actually, Voigt's method is routinely used in acoustics and in aeronautical engineering, but not cited as such. Instead, it is customary to claim that use has been made of the Lorentz transformation. The reference to Voigt would be not only historically correct but helpful in making the distinction between different uses of the invariance. In acoustics, the ether exists and the invariance does not give the complete solution for the moving source: Its interaction with the medium has to be specified. The reason that aeronautical engineers make wide use of these ideas is that the "sources" are sleek (at least ideally), so their interaction with the medium can often be described in the framework of the linear wave equation.

It may be worth noting that 1887 was also the year in which Ernst Mach gave the experimental evidence for the existence of what is called today a Mach cone or Mach wave, the disturbance caused by a body moving with supersonic speed.[3] The connection with relativity is somewhat tortuous: One can note that if the velocity of light were not the highest possible speed in vacuum, space would be filled with Mach waves, that is, with Čerenkov radiation. Actually, Mach only confirmed experimentally what was predicted 40 years earlier by Doppler, who gave a classification of the possible field geometries generated in a homogeneous medium by a moving source. His arguments were based solely on the constancy of the wave propagation speed relative to the medium. Doppler's role seems now to be overshadowed by Mach's contribution, particularly after the wide acceptance of the notion of the Mach number, but I think it should not be forgotten.[5]

References

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3. E. Mach, P. Salcher, Wiener Ber. **95**, 764 (1887).
4. C. Doppler, "Über den Einfluss der Bewegung auf die Erscheinungen der Äther-, Luft-, und Wasserwellen," Abh. Böhmischen Ges. Wiss., V. Folge (1847).
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