Walker in the widely respected (if apparently unread) *Astrophysical Journal*.

WILLIAM P. BIDELMAN
Case Western Reserve University
Cleveland, Ohio
10/87

ANDERSEN REPLIES: My sentence "New observations indicate rapid core rotation in both M31 and M32" may have been somewhat misleading. I have asked John Tonry (MIT) and Douglas Richstone (University of Michigan) to help me clarify the relationship of Walker's observations to the recent work. In observational accuracy and realistic modeling of the nucleus, the new data analyses go far beyond what Walker was able to achieve. The real novelty is not the fact of the rotation but the recognition that the atmospheric blurring may be hiding a discontinuous rotation curve and that there must be substantial dark matter in the form of black holes or neutron stars in the galactic nucleus. In 1962 it was thought that galactic nuclei, like globular clusters, would have a decreasing mass-to-luminosity ratio toward the center, that is, *less* dark matter than the outer parts. (Walker states in his conclusions that his observations support this view.) In any case, Walker's contributions have not been forgotten; his paper (*Astrophys. J.* **136**, 695, 1962) is referenced in the papers mentioned in the PHYSICS TODAY news story.

Make Assistantships Available to PhDs

According to the November 1987 issue (page 86) about half of the graduate students in US physics departments in 1986 were foreign students. Many of them are holding down low-paying research and teaching assistantships amounting to $8000–$9000 a year. Some schools do not exhaust their allotments of such assistantships.

At the same time, persons with the doctorate degree, like myself, are supporting families on unemployment insurance of $1000 a month. Should not our universities make these assistantships available also to needy persons having a PhD but no job?

I have responded to the advertisements in PHYSICS TODAY for faculty positions; the letters that come back often are accompanied by glowing descriptions of the experimental research assistantships—*available only to graduate students.*

Any department chairman must

be aware that an enormous oversupply of PhD holders is afloat in this country. It is a national disgrace that many of these talented people must see their abilities go unused while a kind of reverse discrimination in hiring foreign graduate students persists.

JAMES J. KLEIN
11/87 *St. Cloud, Minnesota*

Recognition for Waldemar Voigt

In an interesting historical note in the September 1987 issue (page 11) Nicholas Rott pointed out that 1987 was the centennial of the discovery of the Lorentz transformation by Waldemar Voigt.[1] According to Rott, Voigt was reputedly disappointed at the lack of recognition that his discovery received. He had reason to be. Nevertheless, Wolfgang Pauli's *Relativitätstheorie*[2] is not the only book to mention Voigt's discovery, although its dismissal as a mere mathematical result by that hypercritic did not help Voigt's press. What Voigt actually did was show that the wave equation is covariant under his transformation—certainly a physical result.

Through the years there have been other references to Voigt's discovery by those who have taken the trouble to read the original literature, among them August Kopff,[3] Max von Laue,[4] Max Born,[5] Francis Sears and Robert Brehme,[6] and Anthony French.[7] There are doubtless many others. In fact, Arthur O'Rahilly,[8] in his scholarly, critical and quaintly idiosyncratic examination of the fundamentals of electromagnetic theory, devotes an entire chapter, entitled "Voigt," to the Lorentz transformation. Too bad Voigt did not live to see it. However, Voigt did live to see his paper chosen to be reprinted in its entirety in the *Physikalische Zeitschrift* (a German PHYSICS TODAY of his time) on the occasion of what the editors called simply the tenth "birthday celebration of the principle of relativity."

There is no doubt that Voigt really did discover what we have chosen to call the Lorentz transformation. But what we surely should like most to know is what Hendrik Lorentz himself thought. Fortunately he tells us, with characteristic generosity, in his great classic *The Theory of Electrons.* Because of the historical importance of Lorentz's views and because his brief footnote is even less known than the work it cites, I quote it as it appeared in 1909. (The number (6) refers to the wave equation, and (287) and (288) refer to the Lorentz transformations. The italics are mine; Lorentz italicized only the word "free.")

"In a paper 'Über das Doppler'sche Prinzip,' published in 1887 . . . and which to my regret has escaped my notice all these years, Voigt has applied to equations of the form (6) (§3 of this book) a transformation equivalent to the formulae (287) and (288). *The idea of the transformations* used above (and in §44) might therefore have been borrowed from Voigt *and the proof that it does not alter the form of the equations for the free ether is contained in his paper.*"[10]

References

1. W. Voigt, "Über das Doppler'sche Prinzip," Göttinger Nachr., 41 (1887).
2. W. Pauli, *Relativitätstheorie* (*Enzyklopädie der Mathematischen Wissenschaften*, vol. 19), Teubner, Leipzig (1921).
3. A. Kopff, *The Mathematical Theory of Relativity*, Dutton, New York (1921), p. 31.
4. M. v. Laue, *Die Relativitätstheorie*, vol. 1, F. Vieweg, Braunschweig (1955), p. 199.
5. M. Born, *Einstein's Theory of Relativity*, Dover, New York (1962), p. 222.
6. F. W. Sears, R. W. Brehme, *Introduction to the Theory of Relativity*, Addison–Wesley, Reading, Mass. (1968), p. 13.
7. A. P. French, *Special Relativity*, Norton, New York (1968), p. 270.
8. A. O'Rahilly, *Electromagnetic Theory*, vol. 1, Dover, New York (1965), p. 324.
9. W. Voigt, Phys. Z. **16**, 381 (1915).
10. H. A. Lorentz, *The Theory of Electrons*, Teubner, Leipzig (1909), p. 198; reprinted by Dover, New York (1952).

WILLIAM T. DOYLE
Dartmouth College
11/87 *Hanover, New Hampshire*

ROTT REPLIES: I am grateful for the numerous references given by William T. Doyle, which refute my contention that Waldemar Voigt's paper "Über das Doppler'sche Prinzip" is forgotten. However, there is an application of Voigt's work that is rarely remembered, and I would like to reformulate it briefly in my reply.

It is undisputed that Voigt discovered in 1887 the invariance of the wave equation with respect to the transformation that is named today after Hendrik Lorentz. In classical mechanics, linear acoustics is synonymous with solving the wave equation. However, this equation is valid only in the privileged system that is at rest relative to the medium. In this situation an invariance is useful for the determination of new solutions. Voigt's invariance leads, when applied to the field of a source at rest, to