

fine $\mathcal{R}_i$ by the following expression:

$$|\mathcal{R}_i|^2 \equiv (\partial R_i / \partial X_j) x_j \dots x_{c+2}$$

where (R_i, X_i) is a conjugate pair of thermodynamics variables such as $(-P, V)$ or (T, S) . Weinhold's papers^{1,2,3} make it amply evident that this is an important alternative way of expressing the content of classical thermodynamics, providing very illuminating ways to view well known relationships and often providing generalizations that would be much more awkward in the conventional formalism. His approach is in the general spirit of recent important work by H. B. Callen⁴ to show that the conceptual basis of thermodynamics is the restrictions on the behavior of the matter that follow from the symmetries of the fundamental laws of physics.

I would like to point out some related geometrical relations, which although not nearly so sweeping in scope or utility as those of Weinhold and of Callen are nevertheless rather interesting and readily accessible to anyone who has a grasp of elementary analytical geometry.

The first law of thermodynamics, in the form $\Delta U = Q + W'$, where U is the internal energy, Q the heat added, and W' the work done on the system, can be seen to conform to the definition of an ellipse as the locus of points such that the sum of the distances from the two foci is constant. A given internal energy corresponds to an infinite family of ellipses but a specific system and/or process would correspond to an ellipse with a given eccentricity and spacing of foci. If the usual convention of treating work done by a system as positive ($W = -W'$) is used, then the First Law can be represented as a hyperbola.

A different and somewhat more interesting approach, which also introduces some new angle variables, is to consider the First Law as

$$Q = \Delta U + W \text{ (general process)}$$

$$\int TdS = \Delta U + W_r \text{ (reversible process)}$$

and the second law as $W_r \geq W$, or $Q \leq \int TdS$. Now imagine a set of generalized coordinates such that velocities squared are proportional to energies, or such that velocities are the square roots of energies with the proper choice of the "mass." Thus $(\Delta U)^{1/2}$ acquires the interpretation of a velocity or a momentum, as do $Q^{1/2}$ and $W^{1/2}$. With this interpretation, the first law is seen as a relation between the squares of vectors, and in fact, as the condition for a right triangle with sides $(\Delta U)^{1/2}$ and $W^{1/2}$, and hypotenuse $Q^{1/2}$. The figure shows the triangle for the first law and neatly reduces the second law to the statement that the triangle for a general process must lie within or on the one

for a reversible process, or that the angle α_r between $(\Delta U)^{1/2}$ and $(\int TdS)^{1/2}$ for the reversible case must equal or exceed α for the general case. For a specified system and process, the irreversibility is characterized by the angle $\Delta\alpha = \alpha_r - \alpha$. The law of cosines applied to the upper triangle provides an interesting new relation

$$\frac{1}{2} (W_r + W) - (W_r W)^{1/2} = \frac{1}{2} \left(Q + \int TdS \right) - \left(Q \int TdS \right)^{1/2} \cos \Delta\alpha$$

which implies that the arithmetic mean of the absorbed heats exceeds their geometric mean by a larger amount than the arithmetic mean of output works exceeds their geometric mean. When either U , Q , or W is negative, the interpretations are not as simple.

References

1. F. Weinhold, *PHYSICS TODAY*, March 1976, page 23.
2. F. Weinhold, *J. Chem. Phys.* **63**, 2479, 2484, 2488, 2496 (1975).
3. F. Weinhold, *J. Chem. Phys.* **65**, (1976) (to be published).
4. H. B. Callen, *Foundations of Phys.* **4**, 423 (1974).

R. E. BARKER, JR
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5/14/76

UFO journal

In connection with the recent correspondence in your columns about the UFO observations, your readers should be informed of the formation of The Committee for the Scientific Investigation of Claims of Paranormal Phenomena, under the sponsorship of the American Humanist Association. This Committee will publish a biannual journal, *The Zetetic*, this Fall, at \$10.00 per year. The Managing Editor may be addressed at 923 Kensington Ave., Buffalo, N.Y. 14215.

FRANK MORTYN
San Diego, California

6/16/76

Debunking astrology

I wish to comment briefly on your review of *Objections to Astrology* (March, page 54). Your reviewer, Robert H. March, asks: "To whom is this book addressed and what end does it serve?" As far as I am concerned, I made the effort of organizing the articles for the book for two primary purposes, which have been achieved. The first one was to warn young people against accepting astrological predictions without question. The second was to provide them with a clearly written statement showing that astrology totally lacks a scientific foundation.

From 1930 to 1974, I taught regularly at least one half of a beginning course in as-

tronomy, first at Harvard (1930-1956), later at the University of Arizona (1966-1974). During the past few years, I again became quite disturbed by the many requests from my students regarding the astronomical foundations for astrology (or lack of the same) that came my way. I would answer my students' questions, but I could not refer them to any published, up-to-date, concisely written answers to their inquiries. With the recent increase of interest in astrology, and the increase in astrological publications, young folks simply lack a firm statement about the astronomical evidence against astrology and they naturally turn to their astronomy teachers for advice and information. My article was specifically aimed at enlightening the young people who want this sort of information. There are old people who need this information as well, but I do not care as much myself how those folks think. However, it is most important that young people should realize that they must learn to use fully their God-given rights. They must learn to think out their own problems and make decisions wisely themselves, instead of becoming dependent on astrological predictions, as many are today. They must be "tubs that stand on their own bottoms."

As I see it, we have no hope of reforming the dyed-in-the-wool believers in astrology. For some, at least, astrology is almost like a religion, and all I can say is that they hold their beliefs on poor basic grounds. There are others who take advantage of astrology simply for financial personal gain. It does seem to me that I, as an astronomer, trained and supported in my work by public funds, have a duty to inform the general public and warn them that there is no foundation for astrology. I shall continue to do this as best I can, hopefully paralleling my activities with those of many of my scientific colleagues.

Some of my correspondents ask what harm is done by having people believe in astrology—it is all fun and games! Some of the letters I receive show the way in which real harm is being done. The daily columns on astrology in the newspapers (1300 of them) are not just fun. To take an example: One morning our otherwise excellent local morning paper in Tucson omitted the daily column on astrology. There were dozens of telephoned complaints. One came from a woman who was most upset for, because of the omission of the daily column on astrology, she did not know how to organize her day. She was apparently quite desperate about it all. I note that in several letters from astrologers the daily columns on astrology are shown to be of no value. And yet, vast amounts of money are earned by astrologers, and lots of papers are sold because of this admittedly fraudulent practice of serving this daily brew to gullible customers.

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letters

Your reviewer seems to imply that very few people who read daily astrology columns really believe in astrology. In this connection, I would like to note that the recent Gallup Poll (*New York Times*, 19 October 1975) indicates that 32 million Americans "believe that stars influence people's lives." This is a frightening statistic in an age of reason. It shows that it is up to the scientist to inform these 32 million Americans that astrology is pure hokum.

Scientists who do not speak out against astrology are guilty of gross neglect of their social duties.

BART J. BOK

University of Arizona

4/5/76

Surplus equipment

I continue to be amazed by the uninspired policy which we currently employ nationally for the disposition of surplus government equipment of value, in one form or another, for research and teaching purposes. The situation is, of course, that if you are the recipient of support you then qualify for more support, inasmuch as you are eligible to make requests for the acquisition of surplus equipment.

Has any analysis been made of where the equipment ends up and how effective is its utilization? I am not aware of any such study. My guess is that the utilization is poor and that in fact a very large fraction of the surplus material sits in corridors and dead rooms, essentially lost forever.

Here is an alternative policy, surely worth a try. Each year large numbers of applicants submit worthy proposals to agencies but are denied support for the well known reasons. Why not offer token grants to the applicants whose proposals for research or instruction are not devoid of merit? Such grants could be, for example, one dollar a year, but carry eligibility to apply for surplus material. Considerably more realistic would be a policy of the award of grants of say, \$1000 to experimentalists who submit good but "unfunded" proposals. Then not only would we be eligible to apply for surplus equipment but we would also have some money to pay shipping charges.

ARTHUR R. QUINTON

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6/23/76

Unauthorized alterations

I would like to raise a question about the publication process which has not been mentioned in previous correspondence in these columns. Specifically I am referring to the alteration and re-writing of papers after their acceptance and without the author's permission or knowledge, at

least until the proofs are received with a strongly worded note concerning the charging of alterations. I would suppose that failure of an author to protest at this point is taken retrospectively as authorization, although I personally question the validity and propriety of that interpretation. Let me emphasize that I do not question such purely cosmetic alterations as are made to ensure uniformity of style (such as the placement of punctuation in lists of references), but substantial re-writing and re-arrangement with not even a sentence-to-sentence correspondence between the submitted (and accepted) paper and the re-written version.

The publication of papers is such a fundamental part of scientific activity that the need for some public discussion of this issue seems obvious. Also needed is some method by which particular journals may be called to account, as channels of communication within the learned societies which are responsible for most journals can become extremely atrophied at times. Hence the best hope for change, or even discussion, is the force of opinion within the scientific community at large, beyond the speciality concerned.

D. SHER

Cincinnati, Ohio

7/14/76

Physics in poetry

Whether or not your readers agree with Victor Weisskopf that physics is, after all, human, they must surely recognize that he is one of the most human and humane of physicists. His article in June (page 23) demonstrates that again. He is a marvelous bridge-builder between what C. P. Snow called "the two cultures."

The translation of the Goethe poem on light by Weisskopf and Douglas Worth distorts that poet's intent in one small but basic way. Goethe did not write of "chromatic" light—which is colored light or light after it has been split into its component frequencies by a prism or grating. Quite the contrary, he insisted in his *Farbenlehre* that natural light, or sunlight, was unitary, undivided, and integral. Only the artificial tricks and torments of the experimenter (Newton) teased the pure undifferentiated light into deceptive colors. Colors came from the prism!

When Goethe in that poem called on his friends to recognize the general and eternal basis or foundation of the *Farbenlehre*, he meant his own doctrine or dogma, which he set forth finally in a vast and largely fallacious treatise, known as the *Farbenlehre*.

Whitman's haunting poem *When I heard the learn'd astronomer*, quoted by Weisskopf, may well be compared or contrasted with poems of the one later great American poet well versed in modern science: Robinson Jeffers (1887—