

May, 1994

## More on twinkling

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end of a spring scale. Students see the substantial difference in weight. However, when each cube is lowered into the water, the digital balance will show the same increase (and the spring scales will show the same decrease) and not more for the lead block, as students usually expect.

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### More on Twinkling

Dr. Matt Young, a physicist at the National Institute of Standards and Technology (Boulder, CO 80303-3328), has convinced us that the color-twinkling effect described in our recent note<sup>1</sup> results from interference, rather than from the image wandering from a cone of one color to another as we suggest. As Dr. Young points out, "...the pixel as you define it would occupy several cones. In dim light the pupil opens wide, the system becomes aberration-limited, and the effective pixel becomes larger yet. Therefore, the image of the star is not anywhere near a point and does not wander from red cones to blue cones but rather covers a great many cones at one time."

Dr. Young's explanation of the phenomenon is, "...stars twinkle because starlight is coherent over the diameter of the pupil, whereas 'planet-light' is nearly incoherent. Turbulence in the atmosphere brings about random phases, and sometimes one color is reinforced, sometimes another....A laser scientist would probably say that the atmosphere creates a giant speckle pattern that varies with time. The eye is thus sometimes located at a peak of the red speckle pattern, sometimes at a peak of the blue speckle pattern. Hence the stars twinkle and, if they are bright enough, show colors as well."

This explanation, involving atmospheric conditions, nicely explains why the color-twinkling effects vary from one night to another, and occasionally are not apparent or almost not apparent. Also supporting Dr. Young's explanation is the fact that we have found that this twinkling is still observed, but is not enhanced, when a 2-mm aperture is placed directly in front of the eye, which would reduce the pixel size in a dark-adapted eye to approximately 0.5 minutes of arc.

We thank Dr. Young for setting the record straight.

#### Reference

1. J.S. Huebner and T.L. Smith, *Phys. Teach.* **32**, 102 (1994).

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### Oldie...But Not Golden

Newton's First Law states that the motion of a body persists in the absence of a net external force. It also presents the concept of a force as that which changes the velocity of a body. It is even the basis for the definition of an inertial reference frame. However, the effect of a given force when applied to *different* masses is outside the purview of the First Law, and is properly the subject of the Second Law. The "Golden Oldie, Newton's First Law Demonstration" [*Phys. Teach.* **32**, 117 (1994)] contrasts the effect of a force acting on a bowling ball with the effect of a similar force acting on a tetherball. Therefore, it is not an appropriate demonstration of the First Law.

The First Law is called the Law of Inertia precisely because it recognizes the persistence of motion in the *absence* of a force; it makes no statement whatsoever that would allow us to distinguish between different masses when acted on by a given force. The First Law may be demonstrated by displaying an object on which the applied net force approaches zero (e.g., an air track glider), or by showing that a force changes the velocity of that object. Any comparison of the effects of a given force acting on different masses should be announced as a demonstration of Newton's Second Law.

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