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Classroom demonstration of sunspots

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The mean surface temperature of the sun is about 4500°K. Various disturbances on the surface cause local temperature fluctuations which are accompanied by corresponding variations in luminosity. The most easily observed surface irregularity is the sunspot which may possess temperatures only as high as about 1500°K. This is well below the temperature of the surrounding medium, and according to the Stephen-Boltzmann law the sunspot will be lower in intensity by a factor of about 100. This will cause the sunspot to appear black against the surrounding brighter background.

It is often explained to the student that the black appearance is due only to contrast, and that the sunspot, if observed by itself, would still be quite bright. This phenomenon can be demonstrated dramatically in the classroom with an overhead projector, projection screen, and a clear tungsten-filament light bulb operated through a variac or dimmer switch.

To perform the demonstration the bulb is placed upon the projector, the projector is turned on, the image of the filament is focused sharply upon the screen, and the current delivered by the variac is slowly increased until the filament glows faintly. The intensity of the filament should be kept low enough to insure that its image still appears black against the illuminated screen (Fig. 1). With the room darkened and the overhead projector turned off the image of the filament will appear bright on the screen (Fig. 2). The effect is usually more dramatic if the students are unable to view the bulb directly since they usually do not anticipate that the filament is glowing.

With the overhead projector turned on, the filament can be made brighter than the screen. This simulates the contrast that occurs on the surface of the sun near the bright areas called plages.

By adjusting the current to the filament, the brightness of the image can be matched to that of the screen; however, it is then observed that the image of the filament does not disappear as one might expect. This is due to the fact that the light from the filament does not possess the same color as the light source in the overhead projector, and neither possesses the same visible spectrum as a true black body.

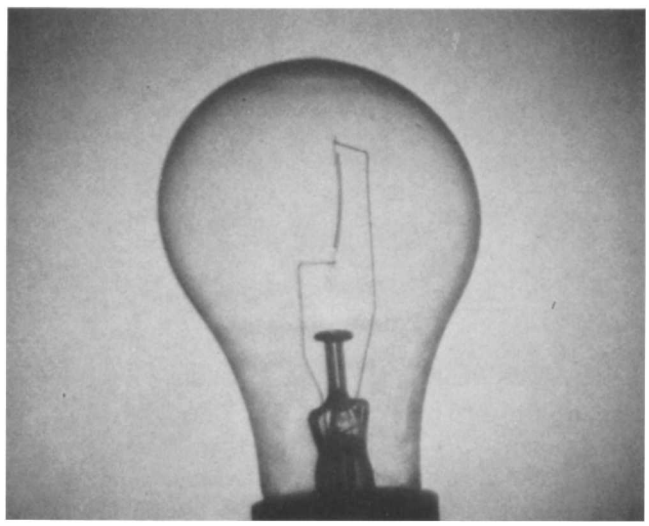

Fig. 1. The image of the clear tungsten filament light bulb as it appears on the screen with the filament glowing red and the projector turned on.

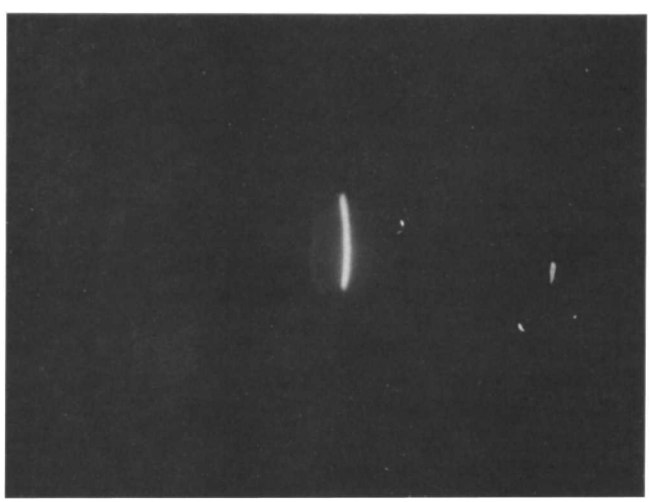

Fig. 2. The image of the filament as it appears on the screen when the projector is turned off.