



Figure 3. The absorption spectrum of the Sun. Each of the dips have well-measured wavelengths, which are caused by absorption by electrons of elements in the Sun's atmosphere (and would appear as dark bands of "missing" colors in the rainbow of light coming from the solar surface). These wavelengths (4314 Å, 5176 Å, 6861 Å, and 7601 Å) can be considered rest wavelengths and could be reproduced in a laboratory. Any shift in these lines (to longer or shorter wavelengths) would be an indication of radial motion between the Sun and the Earth. For example, if the Sun was moving away from the Earth at +50 km/sec, these lines would shift to longer wavelengths (4314.7 Å, 5176.9 Å, 6862.1 Å, and 7602.3 Å).

PROCEDURE

Below, find seven separate spectra obtained from telescopic observations of seven separate stars. A short description will inform you of the spectral line the astronomer was studying, including its origin and, importantly, the spectral line's rest wavelength. For each of the following spectra, calculate the radial velocity (relative to the observer) of the light-producing object and determine from the list below what was happening to that star to produce that line and the observed shift:

- A. Earth-Sized Planet:** A small, Earth-sized planet's gravity will tug on its parent star and cause the star to wobble back and forth in orbit at a low speed, around 0.05 km/sec.
- B. Jupiter-Sized Planet:** A massive, Jupiter-sized planet's gravity will tug on its parent star and cause the star to wobble back and forth in orbit at a moderate speed, around 0.6 km/sec.
- C. Pulsating:** A pulsating star like a Cepheid will expand and contract its entire surface regularly at between 10 to 100 km/sec.
- D. Flaring:** A solar flare – the powerful eruption of gas from the surface of a star as, e.g., the Sun – will travel upwards into space at a speed of, for example, 500 km/sec.
- E. Binary Member:** Stars orbiting another star in a close binary will travel anywhere from 50 to 300 km/sec through orbit; often, spectral lines of both stars will be visible and shifted.
- F. Black Hole Companion:** A star orbiting close to a black hole will be whipped through orbit at incredible speed, in excess of 2500 km/sec.
- G. Supernova Explosion:** An exploding star undergoing a supernova will blast its outer layers into space at gigantic speeds, such as 25000 km/sec or more.