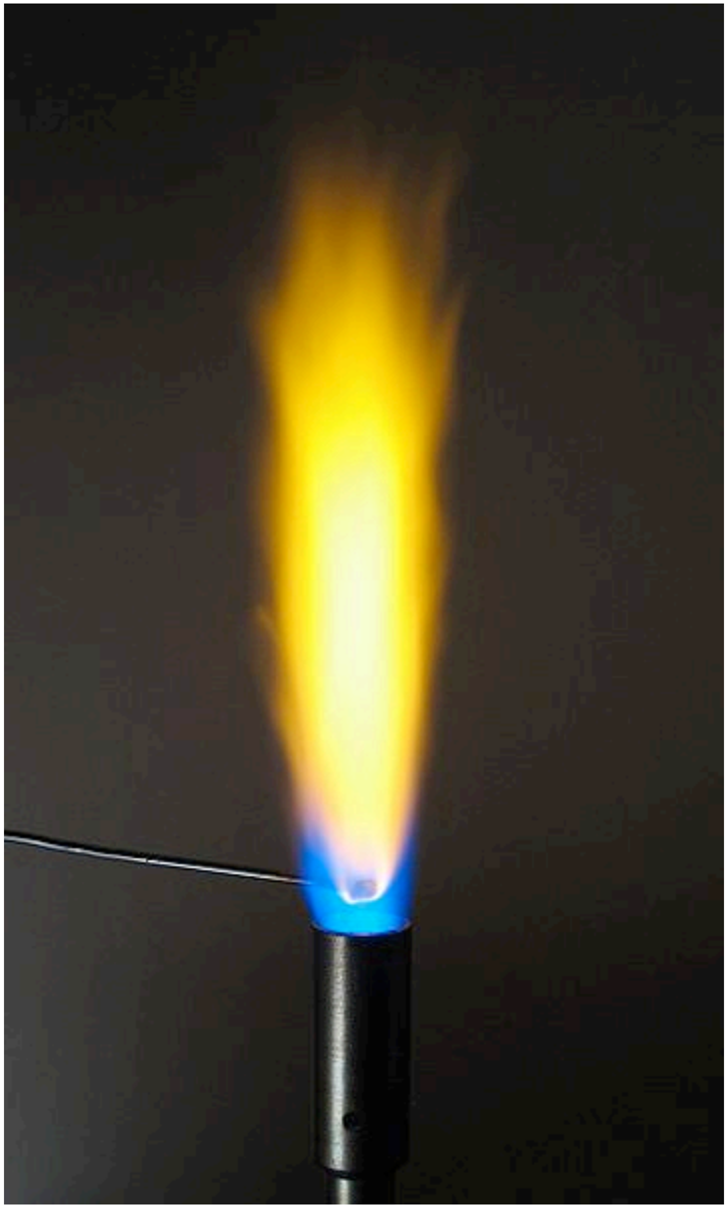
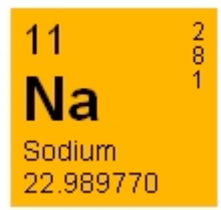
The sodium D-lines



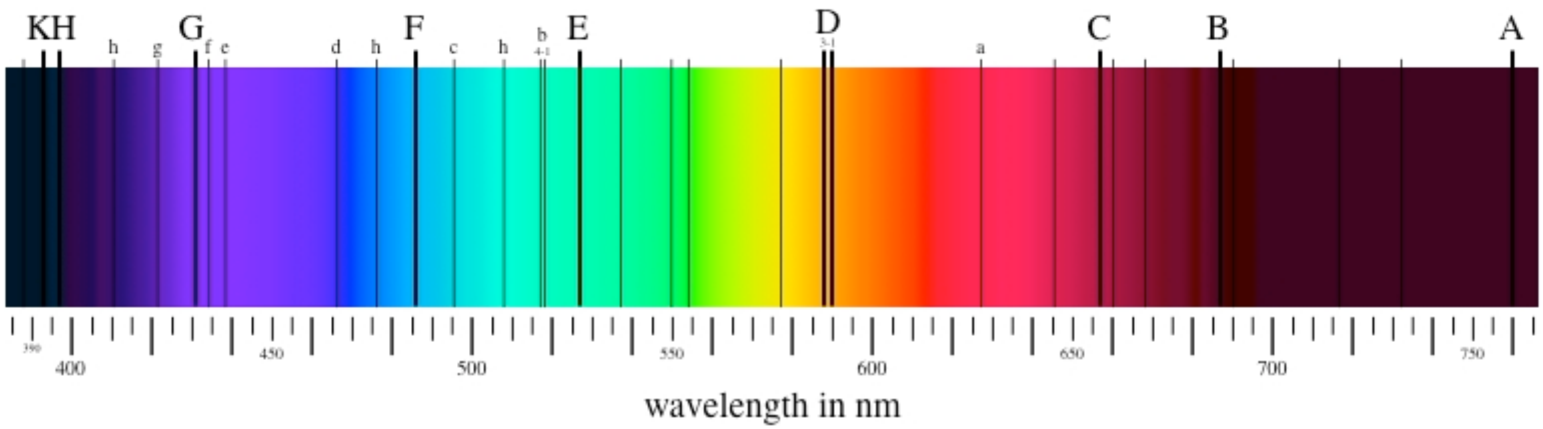
The flame test for sodium displays a brilliantly bright yellow emission. This emission is due to the "sodium D-lines".



$1s^2 2s^2 2p^6 3s^1$
or
$[Ne]3s^1$

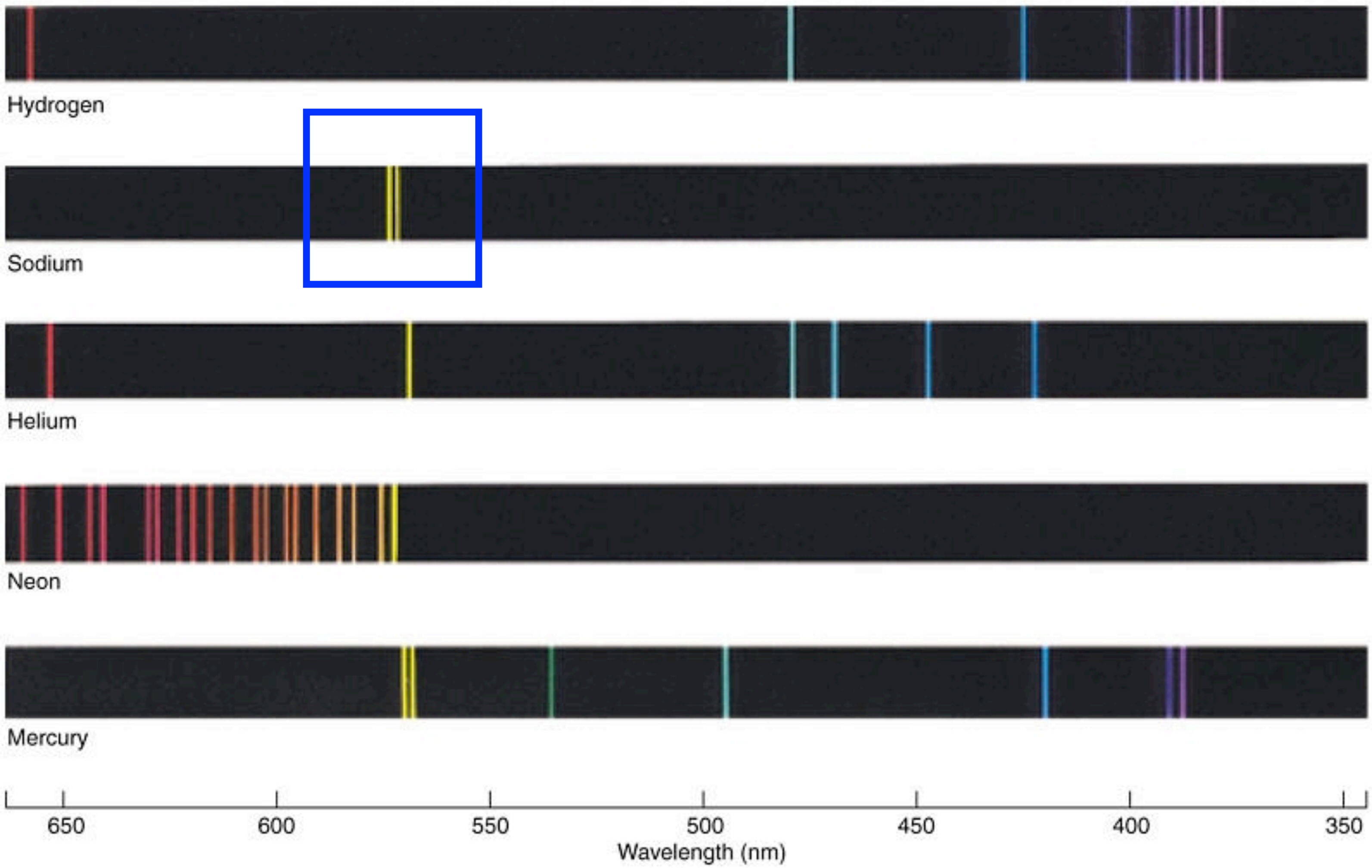
Why and What are D-lines?

Fraunhofer lines



The Fraunhofer lines are a set of spectral lines named for the German physicist Joseph von Fraunhofer (1787–1826). The lines were originally observed as dark features (absorption lines) in the optical spectrum of the Sun. He labeled the lines with letters from A to K.

A strong doublet at 589.0 nm and 589.6 nm is observed in the Sodium emission spectrum, identifying the D-lines as due to Sodium in the sun.



Here's a complete Na spectrum.

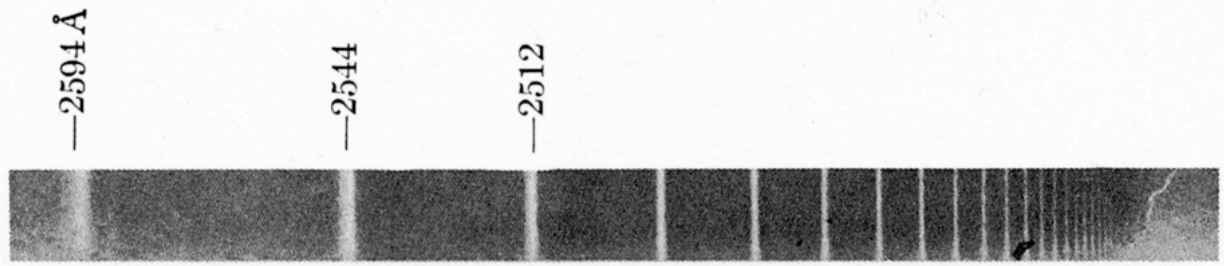


Fig. 2. Absorption Spectrum of the Na Atom [Kuhn (42)]. The spectrogram gives only the short wave-length part, starting with the fifth line of the principal series. The lines appear as bright lines on a dark continuous background, just as on the photographic plate.

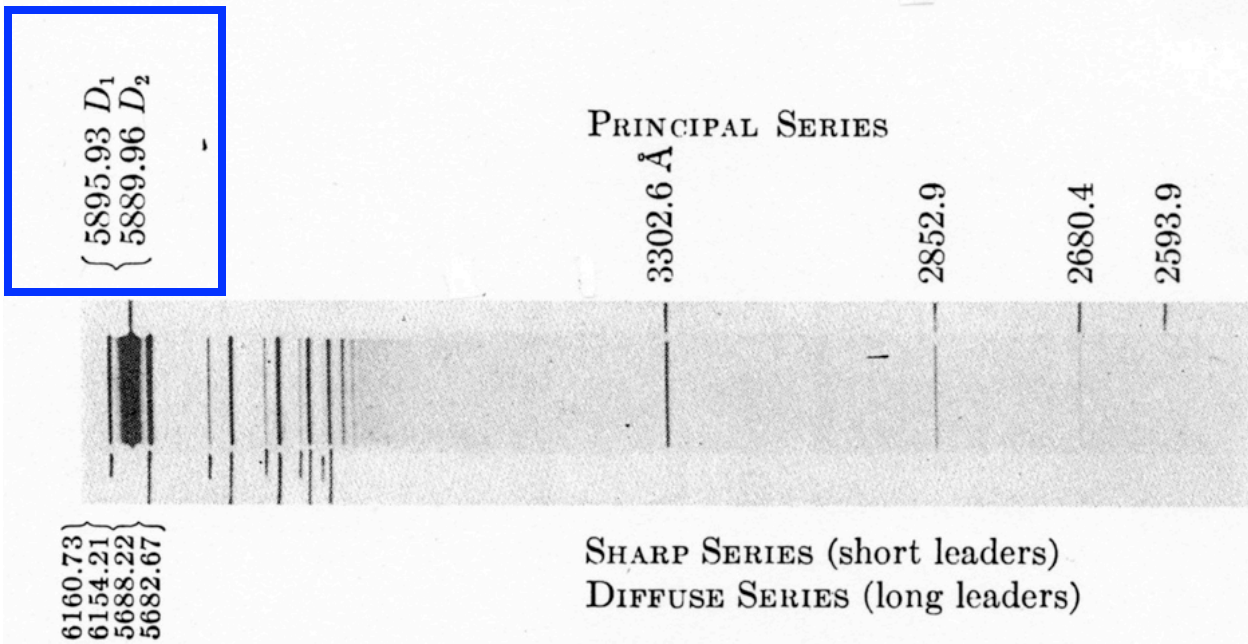
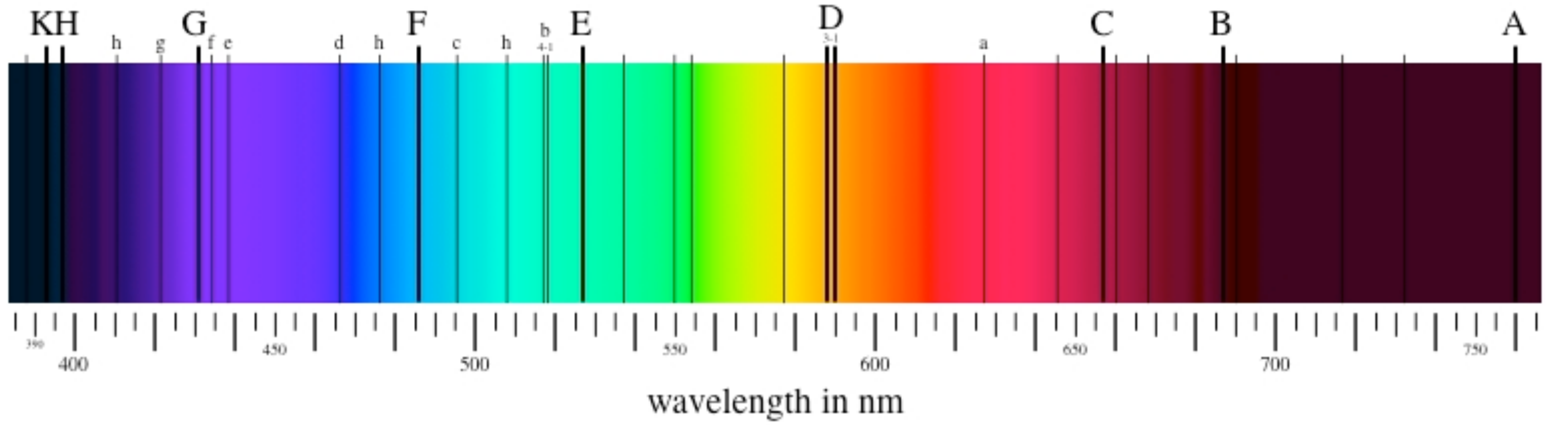
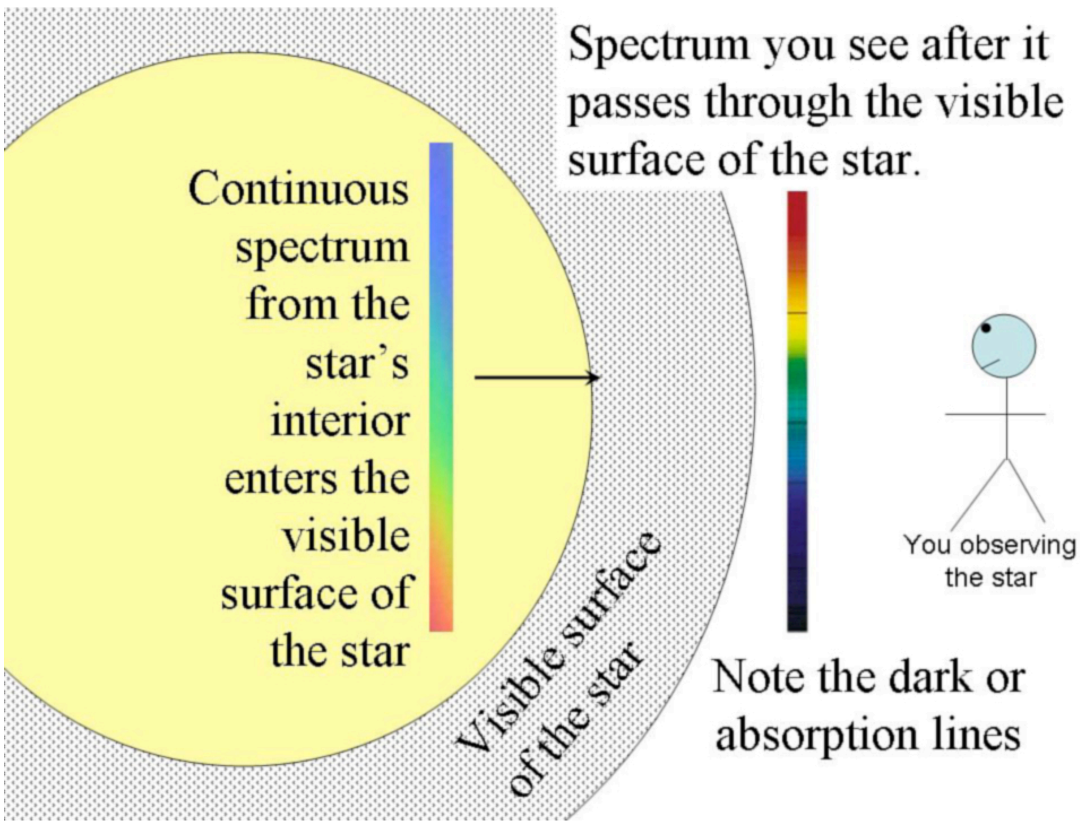
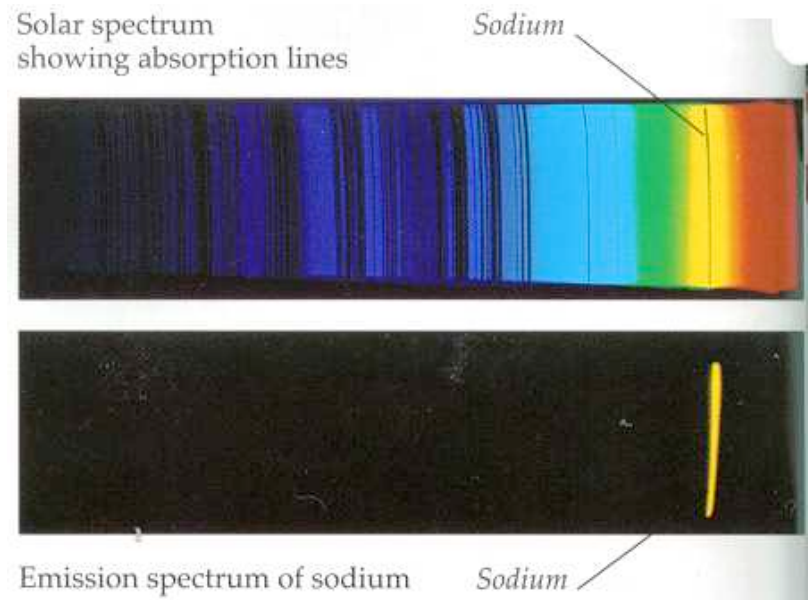


Fig. 3. Emission Spectrum of the Na Atom (Arc with One Na Electrode). Three series can be clearly recognized; one of them, the principal series, coincides with the absorption series of Fig. 2.

Solar Absorption Spectrum

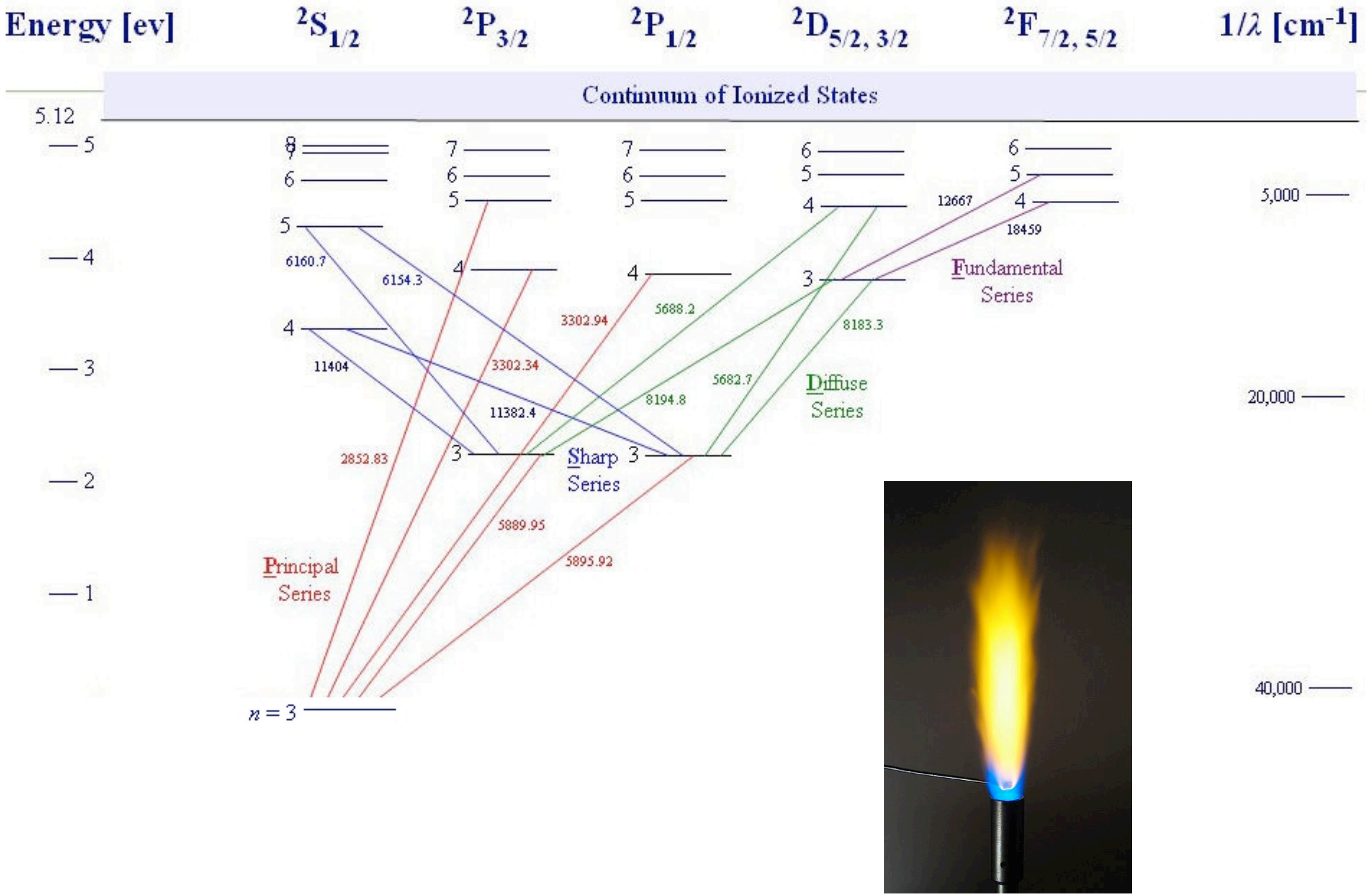






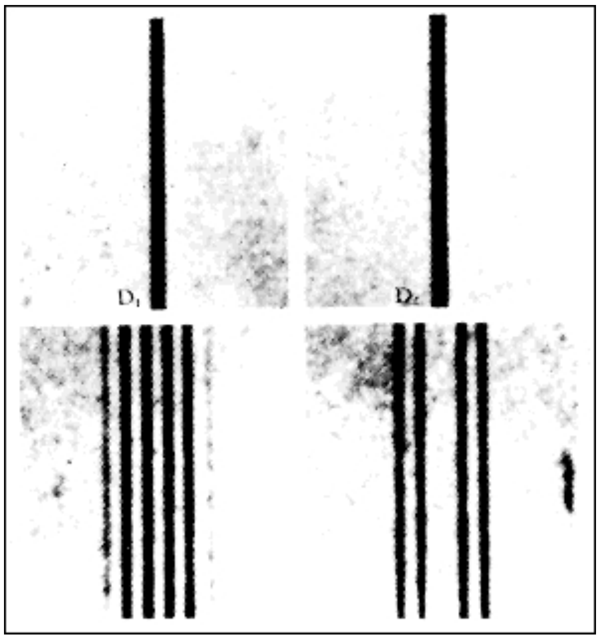
Grotrian Diagram for Sodium

(Transition λs are given in Å. Wave numbers are given in cm^{-1} for recombination photons.)

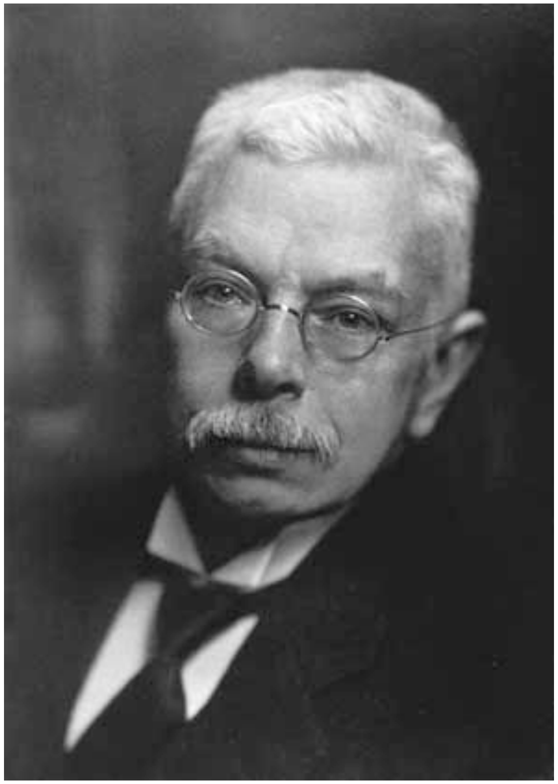


The Zeeman Effect

The Zeeman effect is the splitting of a spectral line into several components in the presence of a static magnetic field.

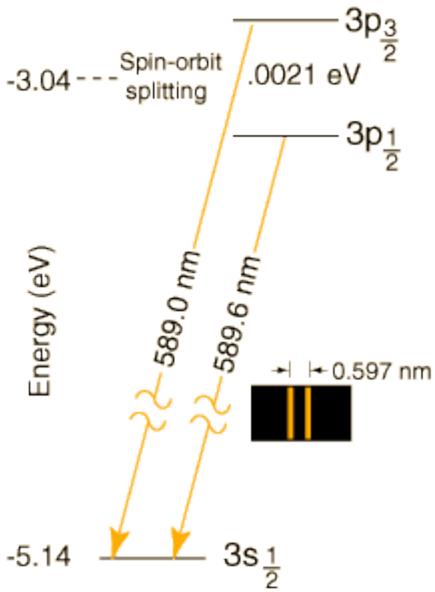


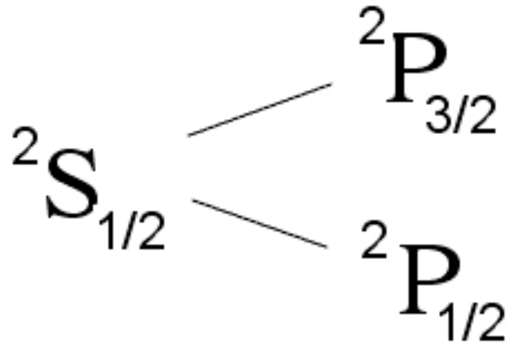
Zeeman's original data was on Na D lines



Pieter Zeeman
1865 - 1943

The sodium doublet is due to spin-orbit coupling of L and S



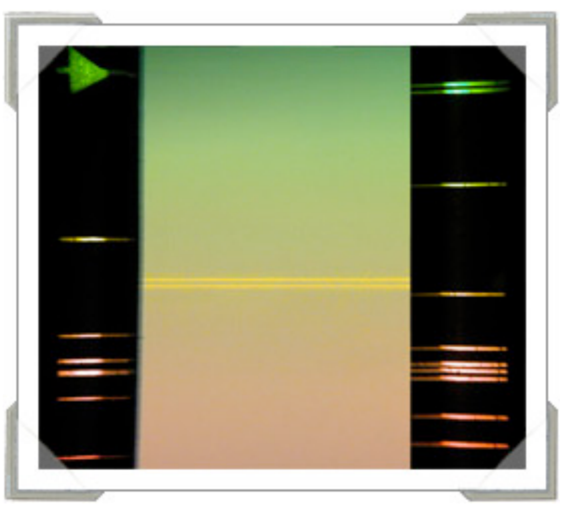


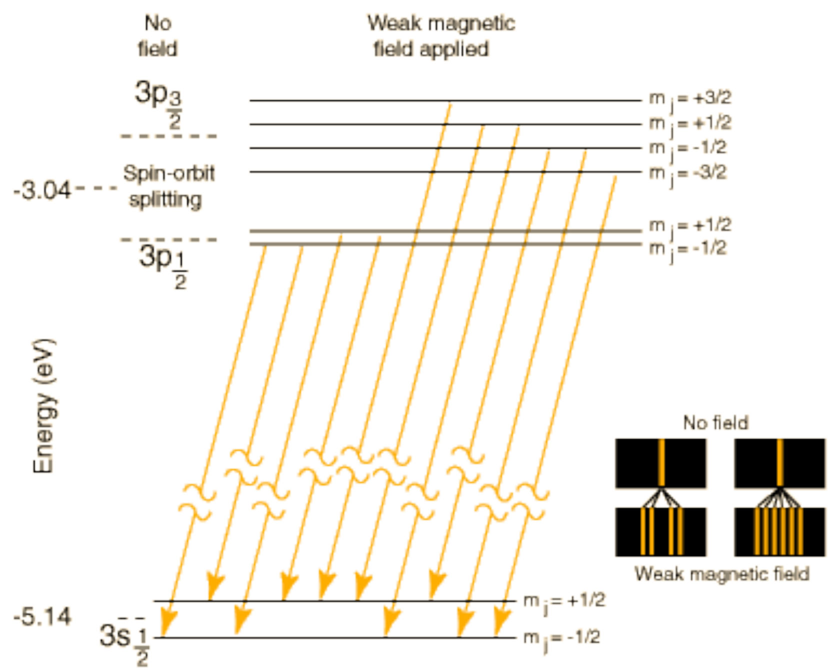
L=1

S= 1/2

J=L+S, L-S

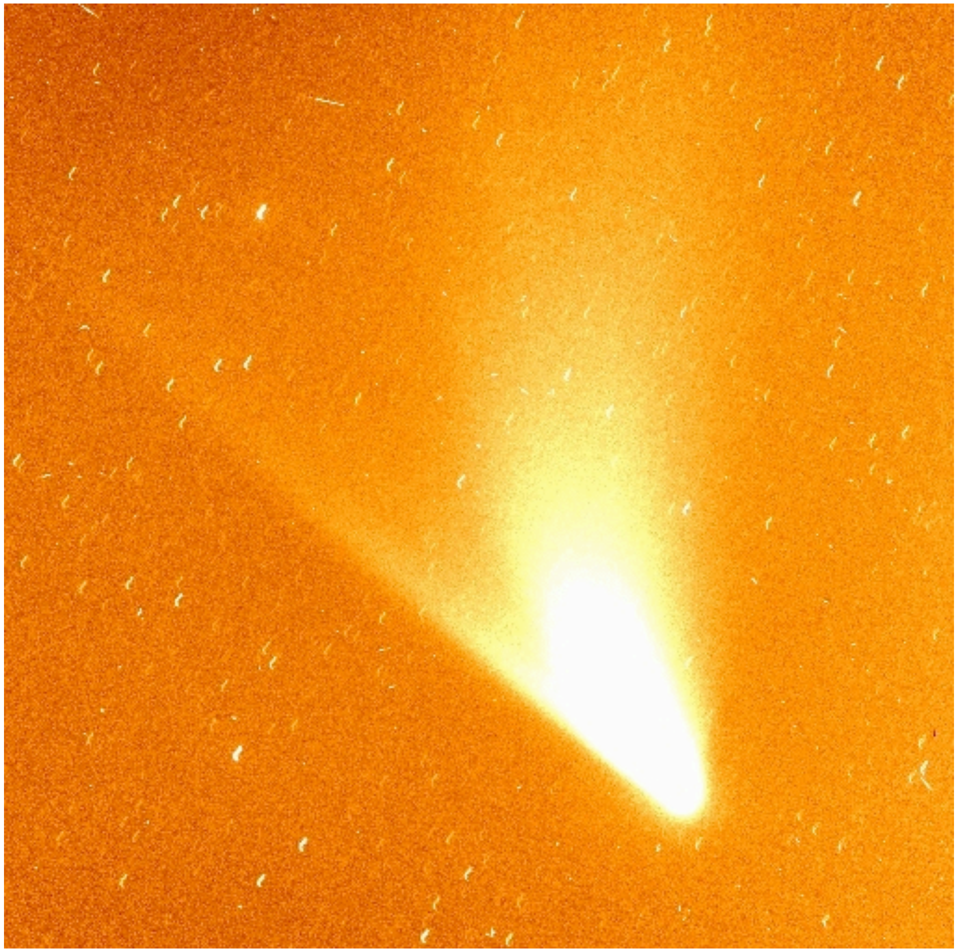
J= 3/2, 1/2



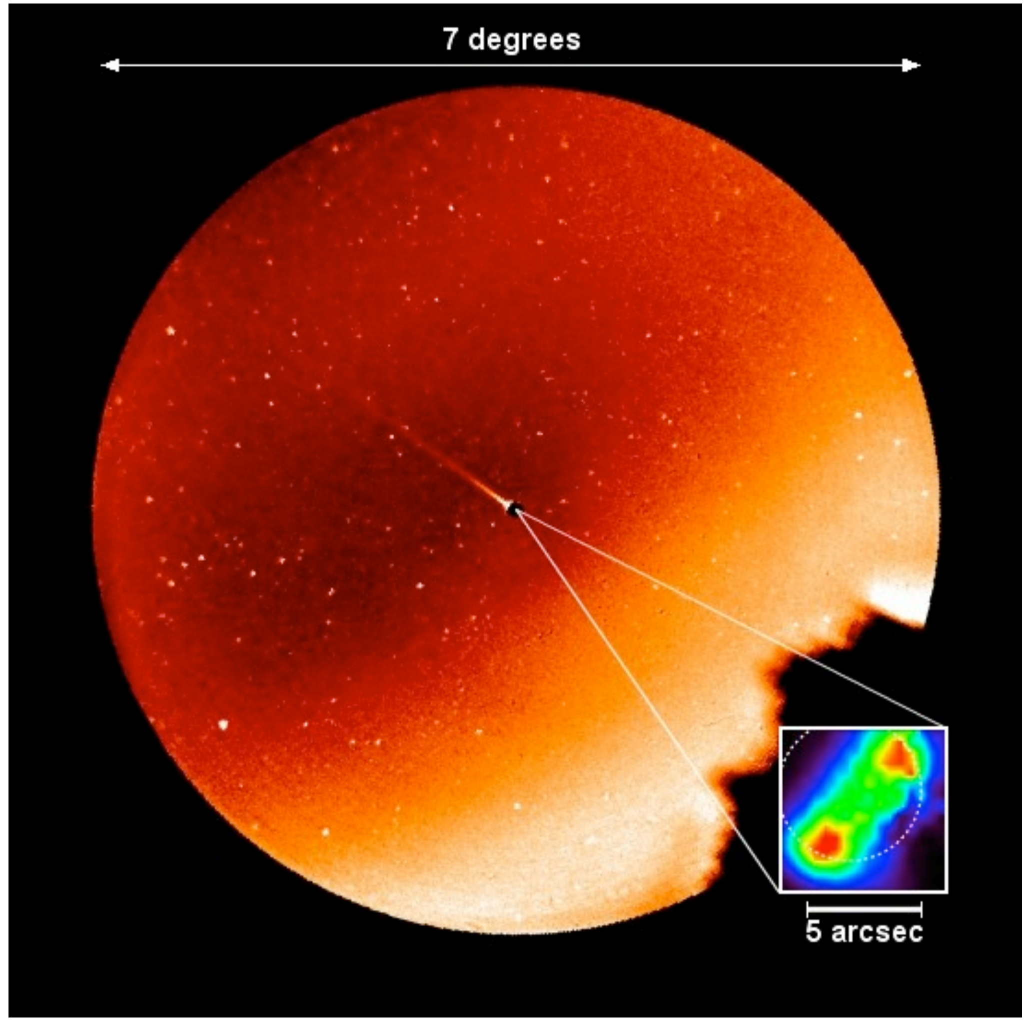


Zeeman effect splits m_J levels into 10 lines

By using a narrow band filter, astronomers can image all sorts of objects for excited Sodium.



Sodium D-line image of the tail of the Hale-Bopp comet.



Sodium D-line images of the comet tail of the planet Mercury.

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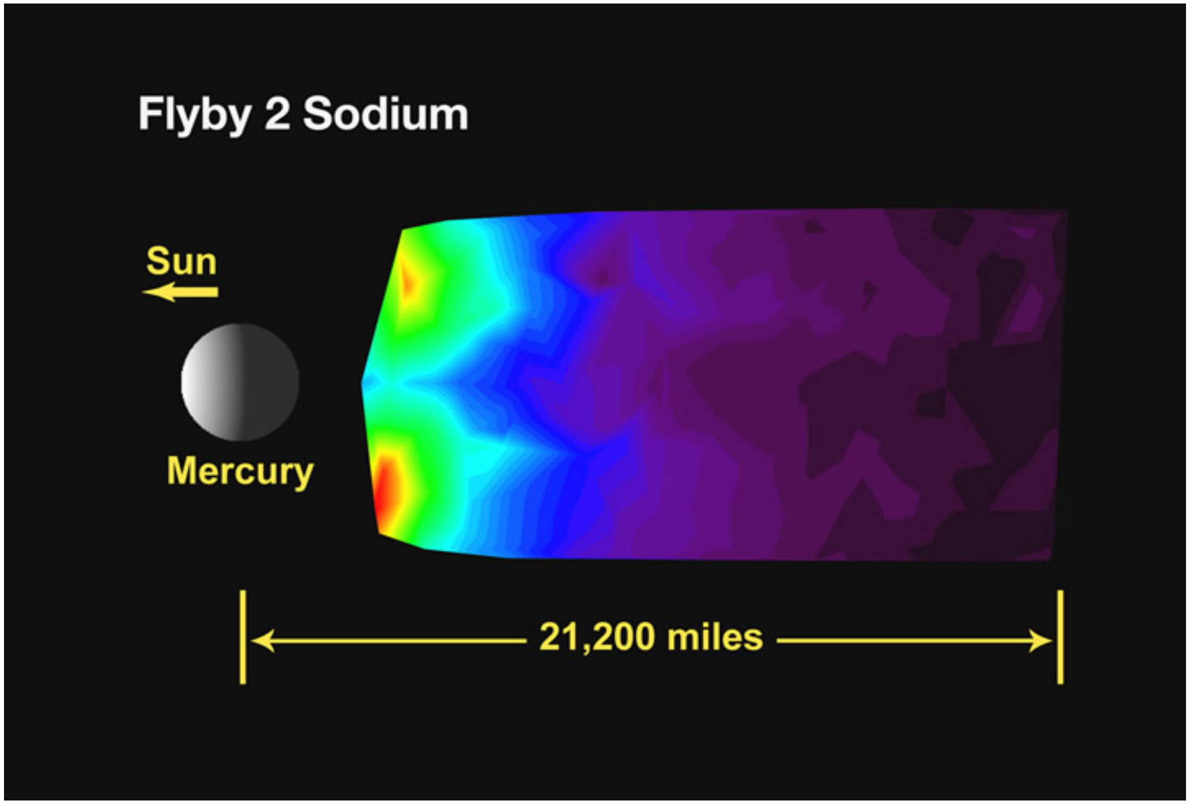
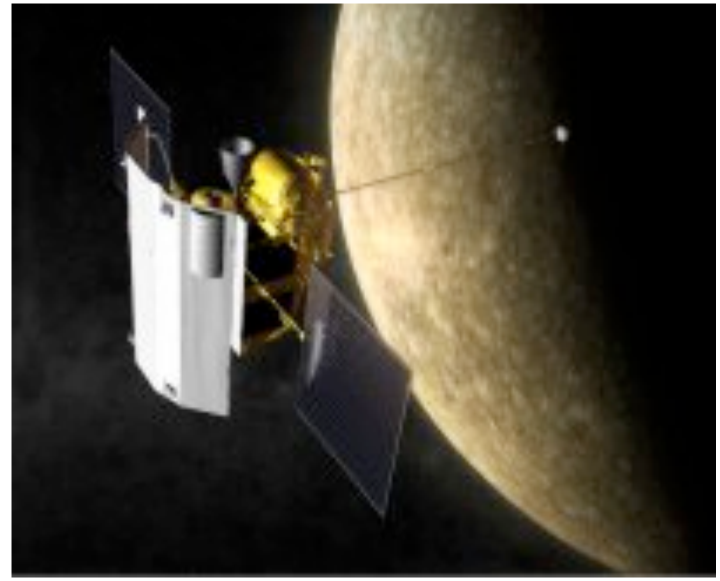
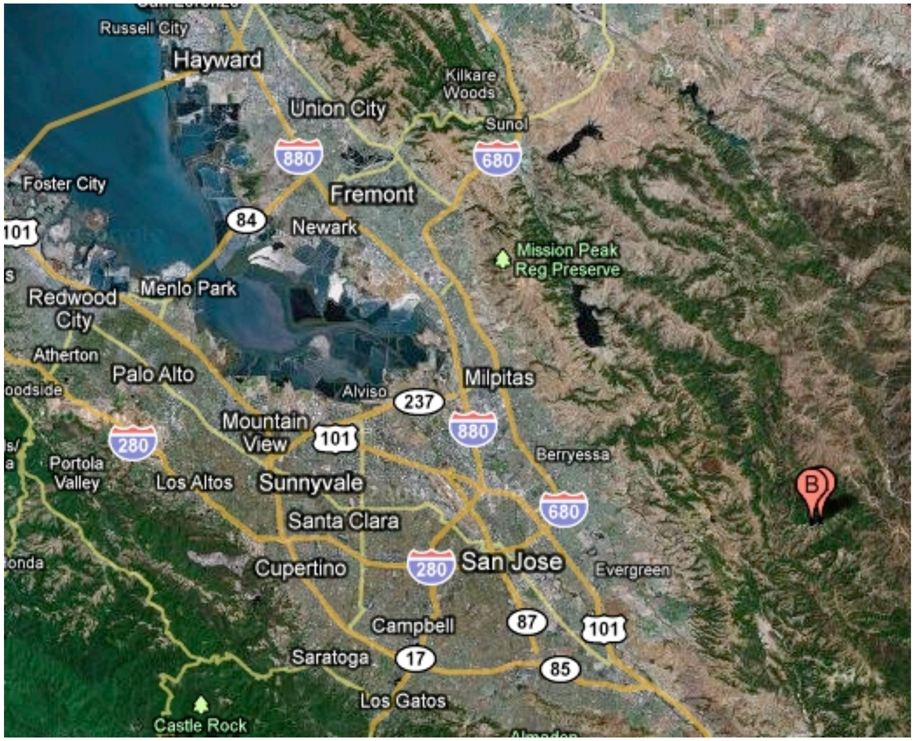


Sodium D-line images of the comet tail of the planet Mercury.



Mercury Satellite Messenger

The Lick observatory on Mt. Hamilton near San Jose (operated by UC Santa Cruz).



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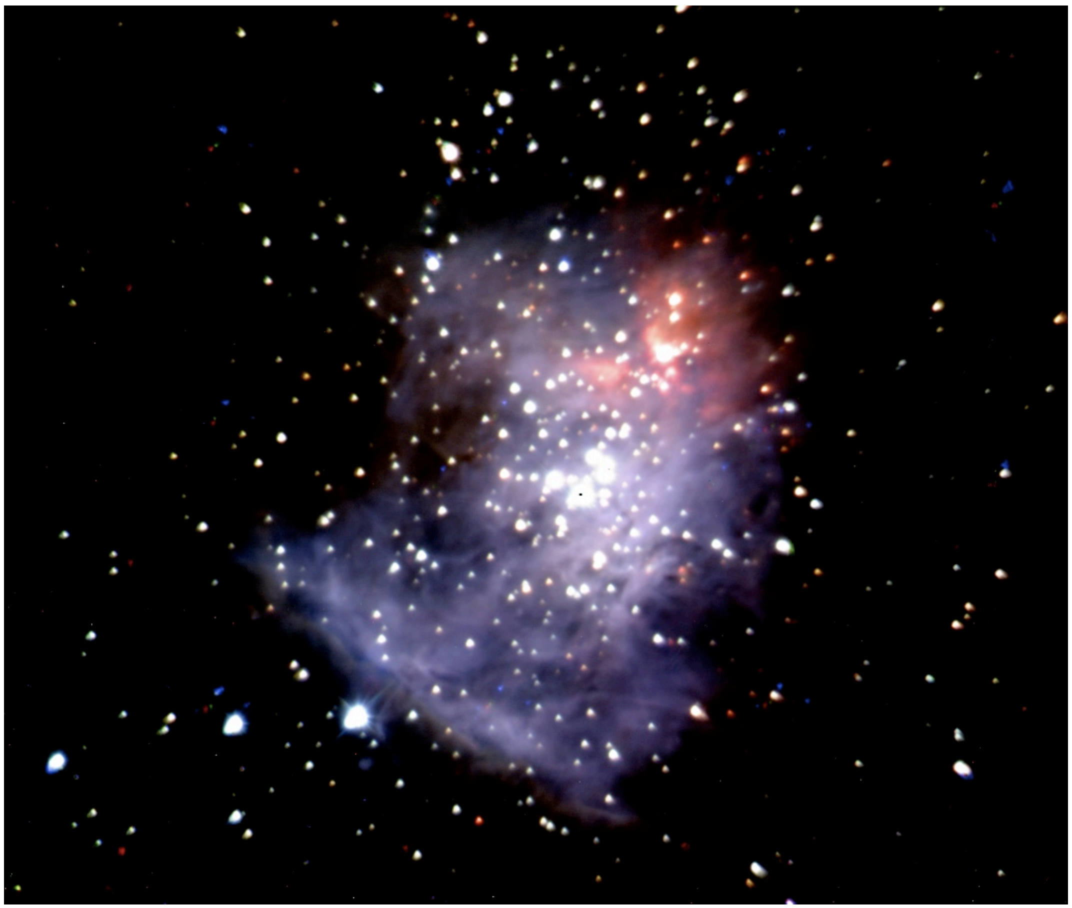
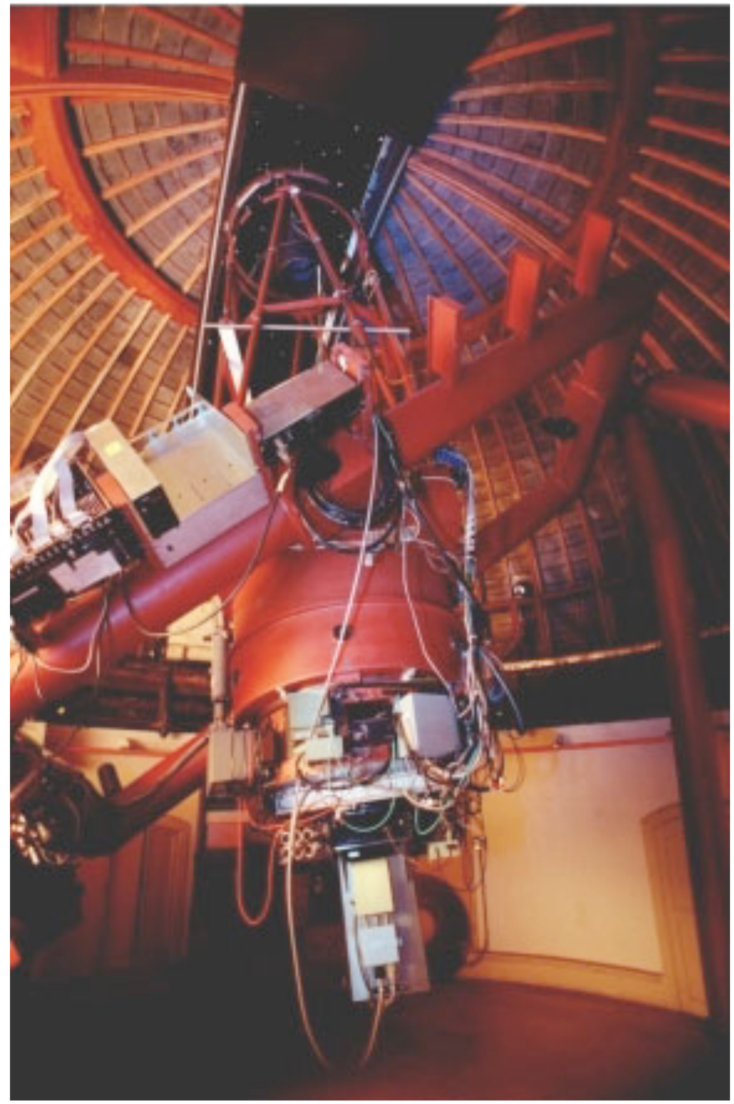
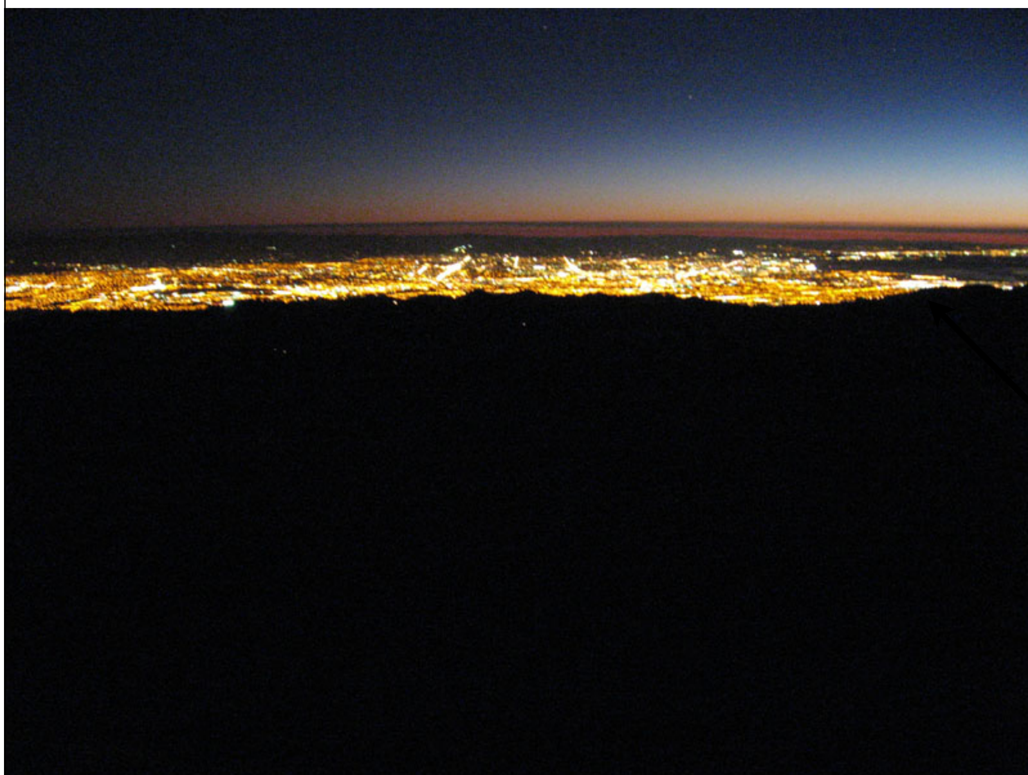
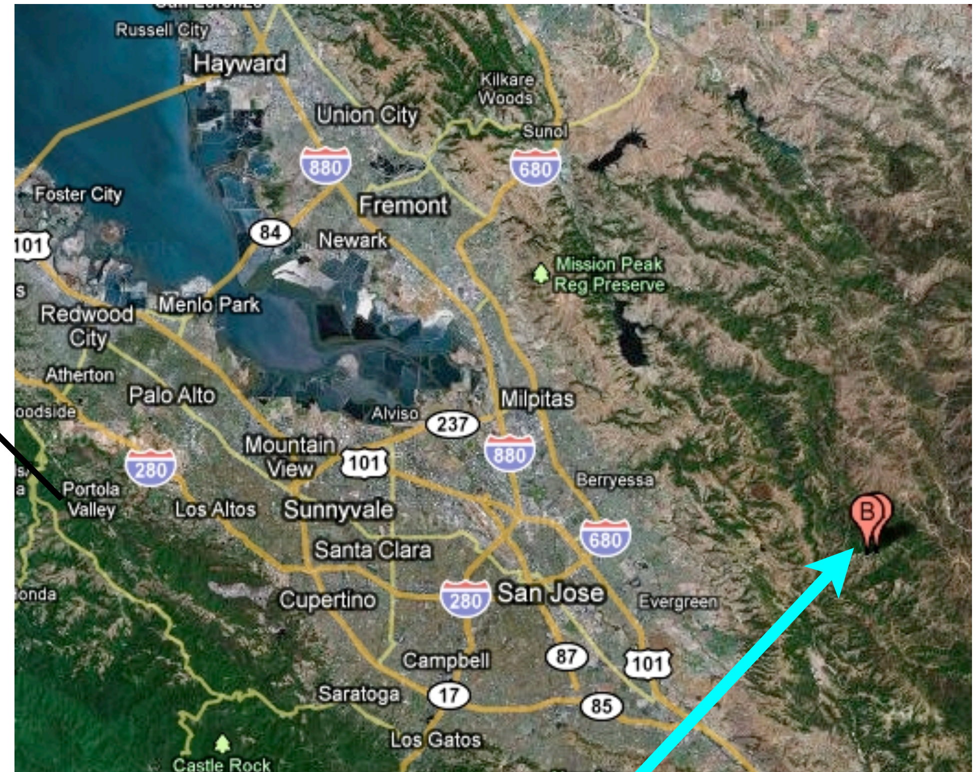




Potential Light Pollution from San Jose.

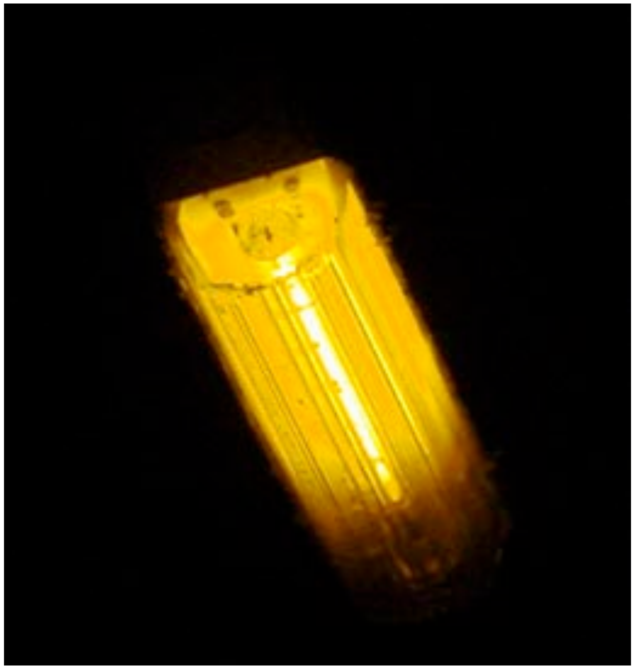


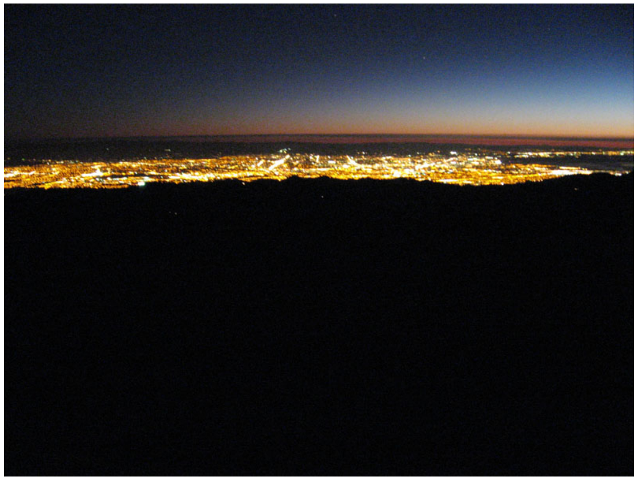
San Jose at Night from Lick Observatory.



Lick Observatory

The solution: The light from Sodium lamps in the streets are removed with a narrow band filter at the observatory!





The Sodium D-Lines are also used to measure Doppler shifts and the size of the universe (Hubble's constant).