

GALAXY SPECTRA

Recall the appearance, stellar populations & colors of galaxies along the Hubble sequence.

Q What would the spectrum of an elliptical galaxy look like?
An $S\phi$?

Q One of my research projects is to look for K giants in the Milky Way halo. One of the contaminants in the survey is distant, unresolved elliptical galaxies. How will their spectra differ from K giants?

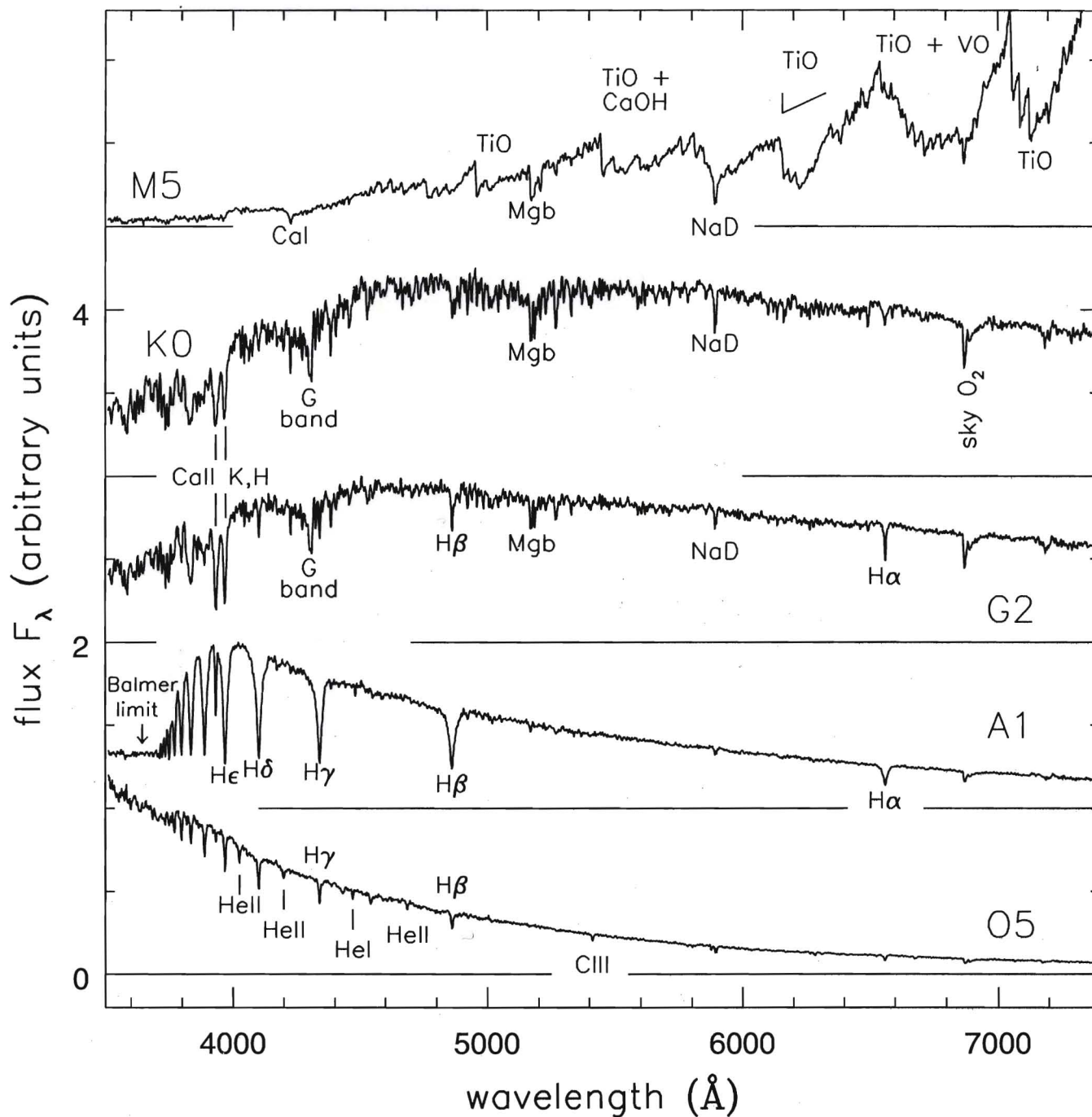


Figure 1.1 Optical spectra of main-sequence stars with roughly the solar chemical composition. From the top in order of increasing surface temperature, the stars have spectral classes M5, K0, G2, A1, and O5 – G. Jacoby *et al.*, spectral library.

The temperatures of O stars exceed 30 000 K. Figure 1.1 shows that the strongest lines are those of HeII (once-ionized helium) and CIII (twice-ionized carbon); the Balmer lines of hydrogen are relatively weak because hydrogen is almost totally ionized. The spectra of B stars, which are cooler, have stronger hydrogen lines, together with lines of neutral helium, HeI. The A stars, with temperatures below 11 000 K, are cool enough that the hydrogen in their atmospheres

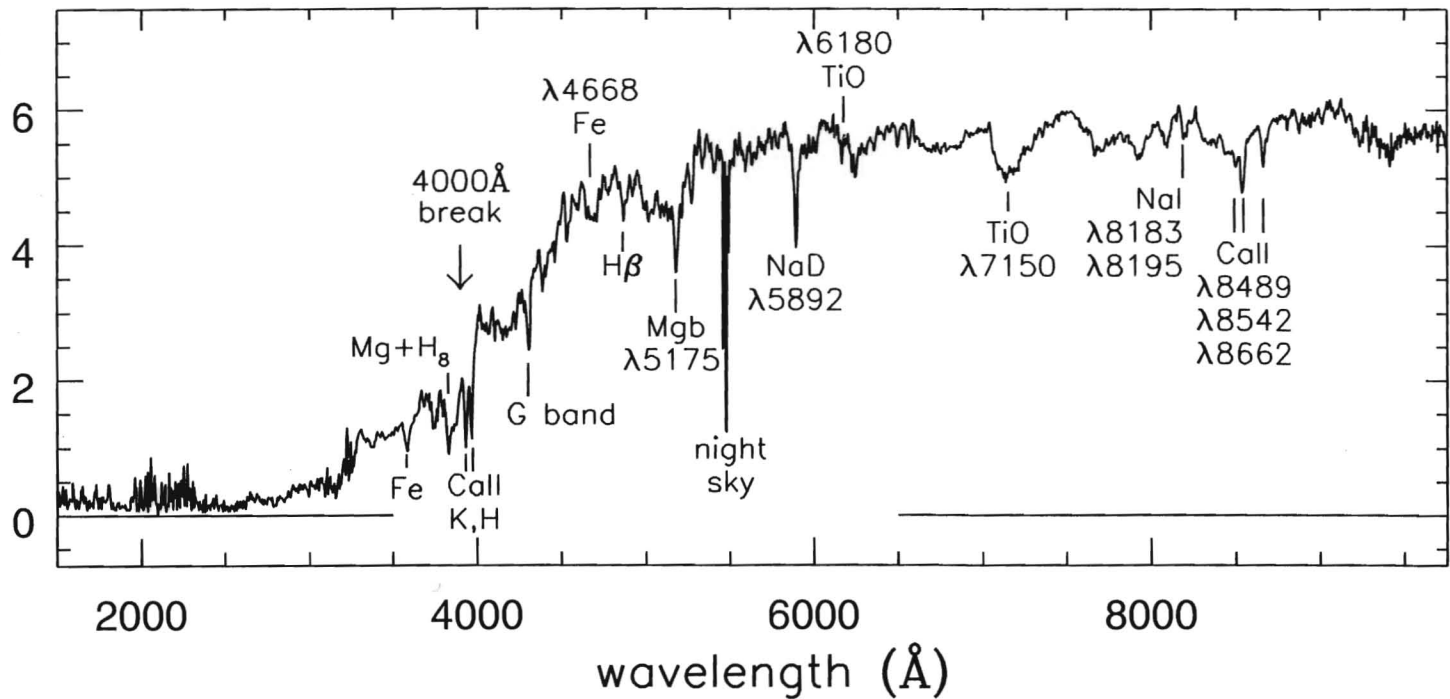


Figure 6.17 Spectrum of an elliptical galaxy; compare with the one in Figure 1.1, and those of disk galaxies in Figure 5.24 – A. Kir

Further reading: Sections 3.3, 3.4, and 4.3 of J. Binney & S. T. T. *Galactic Dynamics* (Princeton University Press, Princeton, New Jersey, 1985). *Does God Play Dice? The Mathematics of Chaos* (1984, Bantam Books, New York, Massachusetts) is written for the general reader, but it gives a good introduction to mathematical chaos.

6.3 Stellar populations and gas

Unlike spiral and irregular galaxies, elliptical galaxies contain few young blue stars; the brightest stars are red giants, and stars near the tip of the red giant branch (AGB: see Section 1.1). We cannot see individual stars in elliptical galaxies more distant than about 20 Mpc; even in the closest ellipticals, we are limited to the AGB stars and those near the tip of the red giant branch. The integrated spectra of ellipticals, such as that in Figure 6.17, show deep absorption lines of heavy elements such as calcium and magnesium, similar to the K star spectrum in Figure 1.1. There is little light below 3500 Å.

Q

What will the spectrum
of a spiral look like?

an $S\phi$?

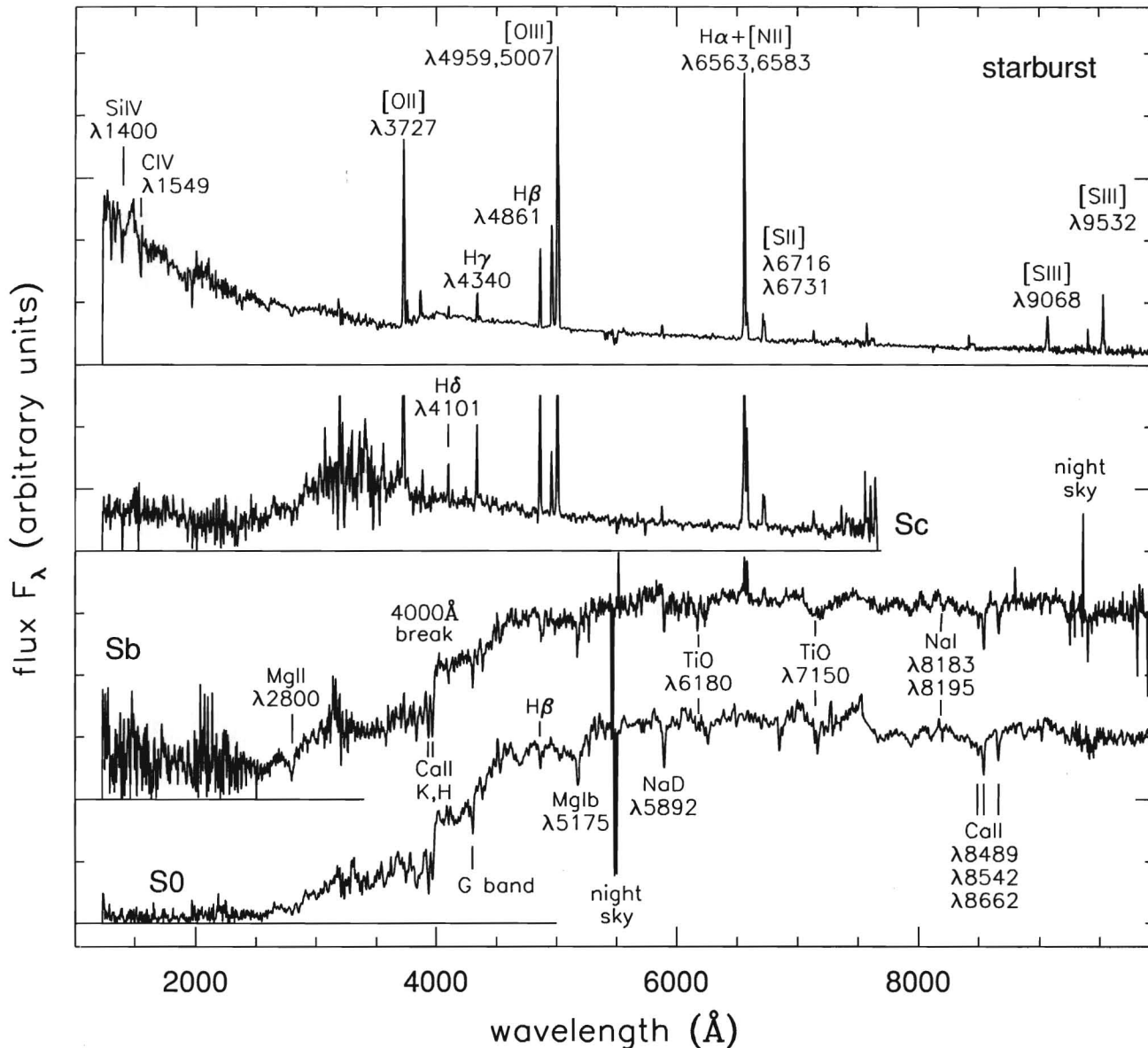


Figure 5.24 Spectra of galaxies from ultraviolet to near-infrared wavelengths; incompletely removed emission lines from the night sky are marked. From below: a red S0 spectrum; a bluer Sb galaxy; an Sc spectrum showing blue and near-ultraviolet light from hot young stars, and gas emission lines; a blue starburst galaxy, that has made many of its stars in the past 100 Myr – A. Kinney.

be higher than in the late-type Sc galaxies, inviting the conclusion that early-type spirals are in general faster rotators. But the most luminous Sc galaxies are rare, and there is none close to the Milky Way. Later surveys further afield revealed very luminous and rapidly rotating Sc galaxies: V_{\max} depends mainly on luminosity, through the Tully-Fisher relation.