Honors Seminar 292 — cheat sheet for 10/14/2019 — Andrew Baker

Anglada-Escudé et al. (2016)

You should read only the main article (i.e., three pages). Key questions:

1. What's *unique* about Proxima Centauri from our point of view?

2. What was the reason for the Pale Red Dot (PRD) campaign of observations of Proxima Centauri?

3. Why do the photometric (i.e., brightness) observations of the star show a period of ~ 80 days that is different from the 11.2 day period of radial velocity observations?

4. What properties of the Proxima Centauri and the planet around it might favor the development of life, and what properties might disfavor the development of life?

5. What conclusions do the authors draw about the formation of the planet orbiting Proxima Centauri?

Key terms:

- **atmospheric erosion** = loss of a planet's atmosphere due to the effects of high-energy photons and/or charged particles impinging on it from the star it orbits

- **Bayesian** = adjective describing a non-frequentist approach to probability, which is thought of as the relative likelihood of a particular *hypothesis* in describing a given dataset

- **chromosphere** = an outer layer of a star's atmosphere, above the "photosphere" that defines its surface, but below the more extended "corona"

- **echelle spectrometer** = an instrument that measures spectra at a very high wavelength resolution, and therefore a very high velocity precision

- **frequentist** = adjective describing a standard approach to probability, which is thought of as the relative likelihood of a particular *outcome* among a large number of identical trials

- **Hα** = emission line from ionized hydrogen

- **hollow cathode lamp** = device for measuring wavelengths and thus radial velocities to fairly (but not very) high precision, based on comparison between an observed stellar spectrum and the spectrum of a lamp containing one or two chemical elements

- **iodine cell** = device for measuring radial velocities to very high precision by superposing the spectrum from a translucent container of gaseous iodine on the spectrum of an observed star

- **Johnson B and V band filters** = devices that allow the transmission of light through standard, broad wavelength ranges that correspond roughly to the blue and green parts of the optical spectrum

- **Keplerian** = adjective describing orbital motion of an object around another that has much larger mass

- **least-squares template matching** = approach in which several different models (templates) are compared to a spectrum, and the model that matches the data most closely is considered to be the best

- **light curve** = how a star's brightness changes with time

- **likelihood function** = quantity that is used to calculate a frequentist probability (higher is better)

- **narrowband filters** = devices that only allow the transmission of light through very small wavelength ranges

- **optimal box-Least-Squares** = computational approach to identifying transiting planets in which the transit signature is approximated as a rectangular "box" with sharp edges

- **overparameterization** = a situation in which so many free parameters are used to adjust a model to match a dataset that the quality of the match is not judged to be very good

- **photometric period** = the time it takes a star's *brightness* to complete one full cycle

- **posterior density** = quantity that is used to calculate a Bayesian probability (higher is better)

- **ratio of evidences** = ratio indicating (in a Bayesian framework) which of two hypotheses is more likely

- **S II** = emission line from singly ionized sulfur atoms

- **spectroscopic activity index** = measurement that can be made to assess how "active" a star's surface is (e.g., in terms of events related to magnetic fields)

- **tidal locking** = phenomenon in which a less massive body orbiting a more massive body always shows the same face towards the more massive body (e.g., as in the case of the Moon orbiting the Earth)

- **type I migration** = the migration of a planet (typically, but not always, inward) caused by the development of spiral density waves in the gas disk in which it is embedded

Lineweaver et al. (2004)

You should read the whole article. Key questions:

1. What are the three key considerations that determine when and whether a planet is "habitable" by complex multicellular life?

2. Why isn't the Sun exactly at the center of the green zone in Figures 3 and 4? Would we expect it to be?

Key terms:

- **accretion** = process by which gas from some external reservoir flows onto or into a massive structure (e.g., a star, a black hole, or a galaxy)

- **active galactic nucleus** = a supermassive black hole at the center of a galaxy that is converting the potential energy of inflowing matter into lots of radiative and mechanical/kinetic energy

- **corotation** = a dynamical resonance in a rotating disk, close to which stellar orbits are unstable

- **cumulative integral** = the total area enclosed under a curve to the left of some value of x

- **kiloparsec** = a distance of about 3000 light-years (the Sun is about 8 kiloparsecs from the center of the Milky Way)

- **molecular clouds** = large clouds of gas that is sufficiently cold and dense that most of the hydrogen content is in the form of diatomic molecules

- **normal distribution** = Gaussian = bell curve distribution

- **starburst** = an event in which a galaxy (or a part thereof) undergoes an unusually vigorous episode of star formation

- **stellar initial mass function** = a mathematical description of the relative numbers of stars of different masses that are formed when a parcel of gas is converted into stars