

Honors Seminar 259 — cheat sheet for 10/8/2008 — Andrew Baker

Endl & Kürster (2008)

You should read the whole article. Key questions:

1. What's *unique* about Proxima Centauri from our point of view?
2. What property or properties of Proxima Centauri make it a good target for a radial velocity planet search? What property or properties might make it not such an interesting target for seeking life?
3. Why are the authors so concerned about the H α line index measurements in Proxima Centauri?
4. What explains the principal features of the authors' Figure 4 (i.e., the "HZ" box, the "1-year window" gap, and the various lines sloping upward from left to right)?
5. The authors' main conclusion is a negative result (these are important to publishes too!): they see no evidence for a planet around Proxima Centauri. Are there any scenarios in which one or more planets could still be present but undetected in their data?

Key terms:

- **AU** = astronomical unit = mean distance of the Earth from the Sun ($\sim 1.50 \times 10^8$ km)
- **barycentric correction** = correction for the motion of the Earth around the barycenter (i.e., the center of mass of the Solar system), which must be applied to radial velocity measurements
- **bootstrap** = a statistical technique used to estimate the uncertainty in a given measurement, which relies on resampling the data one already has and seeing how much one's results change
- **Ca I** = neutral calcium atom(s)
- **convective redshift** = an effect in the atmospheres of certain stars in which the different temperatures of material rising and falling within convective cells lead to an apparent redshift of a given spectral line; this can be suppressed in regions of high magnetic activity
- **ESO** = European Southern Observatory, which operates telescopes in the Chilean Andes
- H α = the transition from the $n = 3$ to the $n = 2$ electronic state in a hydrogen atom; this can produce a very strong emission line in an optical spectrum
- H α **line index** = a measurement of the strength of an H α line relative to the emission at wavelengths on either side

- **Hipparcos** = a space mission that measured the positions and motions of the nearest stars to very high precision
- **HST** = Hubble Space Telescope
- **image slicer** = a piece of hardware that can help take incident light and produce a spectrum
- **K band** = a filter whose central wavelength is in the redmost end of the of near-infrared atmospheric window ($\lambda \sim 2.2 \mu\text{m}$)
- **M dwarf** = a star on the main sequence that has spectral type M (i.e., has a mass lower than that of the Sun, which is a G dwarf, in the OBAFGKM classification scheme)
- **microlensing event** = sudden increase in brightness when the light from a background object is gravitationally lensed by a foreground object that passes in front of it along our line of sight
- **null hypothesis** = the hypothesis about a given dataset that some statistical analysis is (in principle) capable of rejecting
- **parallax** = the angular displacement that a nearby star exhibits relative to more distant background stars on opposite sides of the earth's orbit (a bit like putting a finger in front of your nose and closing first one eye and then the other)
- **pc** = parsec = 3.09×10^{13} km (about three light years)
- **periodogram** = a manipulation of a time series of measurements (e.g., of radial velocities) that reveals how much “power” there is at different frequencies
- **phase angle** = angle describing where in a planet's orbit it is
- **pulsar** = the rapidly rotating, radio-beam-producing neutron star (i.e., a “star” so dense that all protons and electrons have been compressed together into neutrons!) that can be the collapsed remnant left after a supernova
- **resolving power** = $R \equiv \lambda/\Delta\lambda$ = a measure of how finely a spectrum has been sampled in wavelength
- **secular** = adjective describing any process that is slow relative to some main timescale of interest
- **slit width** = dimension of the slit used to pick off light so that it can be split into a spectrum; the narrower the slit, the higher the resolution of the spectrum
- **TPF** = Terrestrial Planet Finder, a possible future NASA mission
- **UVES** = Ultraviolet and Visual Echelle Spectrograph, an instrument on the VLT that takes very high-resolution spectra

- **V band** = a filter whose central wavelength is in the green part of the optical band ($\lambda \sim 5500 \text{ \AA}$)
- **VLT** = Very Large Telescope, a set of four 8 m diameter telescopes in northern Chile
- **window function** = a function of frequency that reflects how much power will end up in the periodogram of a given time series simply as a result of when the observations were made