DETECTING EVOLVED OCEANS ON EXTRA-SOLAR TERRESTRIAL PLANETS

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Currently, the Earth is losing on average 7×10^{26} H atoms s^{-1}. In ~1 Gyr, the Sun's greater luminosity will produce a moist greenhouse effect on the Earth resulting in the oceans evaporating more rapidly and the hydrogen loss rising to $\sim 5 \times 10^{29}$ H atoms s^{-1}. During the ensuing ~5 Gyr, the hydrogen outflow from the Earth will approximately resemble the gas coma around a comet (Jura 2004, ApJ, 605, L65). For an analog to the future Earth, there is a ~3% probability that the planet's neutral hydrogen cloud transits its host star, producing transient, narrow, ultraviolet absorption lines in the stellar chromospheric emission.

The effective scattering area of the Lyman α coma of a terrestrial planet with an evaporating ocean can be $>10^5$ its geometric area, and this large size might be exploited with an ultraviolet-sensitive TPF. Because of interstellar absorption, only 5% of the 180 G-type stars within 25 pc of the Sun can be detected at Lyman α, but 50% of these stars can be studied at Lyman β.

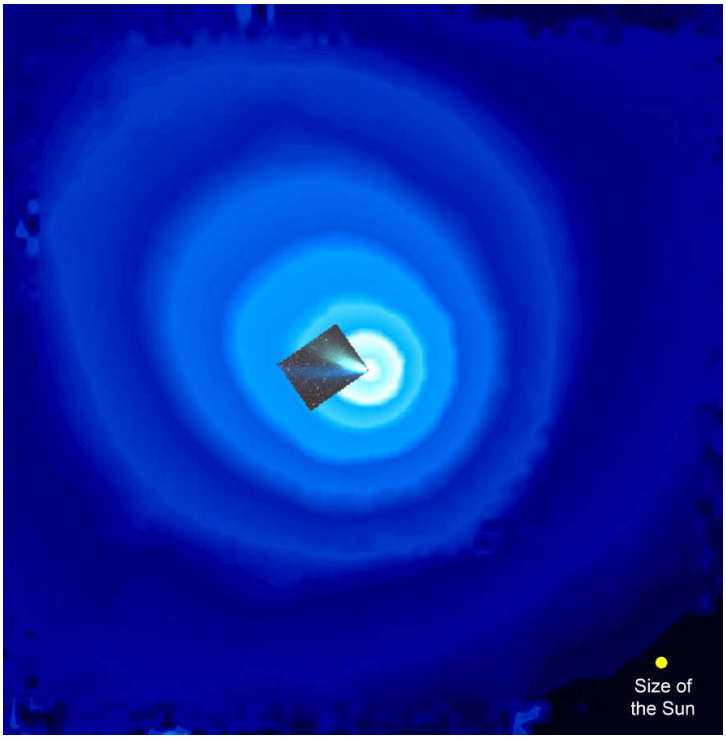

Figure 1: Qualitatively similar to what might be produced by a planet's evaporating oceans, this $40° \times 40°$ image shows the Lyman α scattering halo of comet Hale-Bopp mosaiced with the SWAN camera on the SOHO spacecraft (Combi et al. 2000, Icarus, 144, 191). The yellow dot shows the image size of the Sun, but its location is not to scale. The optical image of the dust tail is shown in the rectangular box.