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302.07 – Discovery of temperate Earth-sized planets transiting a nearby ultracool dwarf star

We report the discovery of three short-period Earth-sized planets transiting a nearby ultracool dwarf star using data collected by the Liège TRAPPIST telescope, located in la Silla (Chile). TRAPPIST-1 is an isolated M8.0±0.5-type dwarf star at a distance of 12.0±0.4 parsecs as measured by its trigonometric parallax, with an age constrained to be > 500 Myr, and with a luminosity, mass, and radius of 0.05%, 8% and 11.5% those of the Sun, respectively. The small size of the host star, only slightly larger than Jupiter, translates into Earth-like radii for the three discovered planets, as deduced from their transit depths. The inner two planets receive four and two times the irradiation of Earth, respectively, placing them close to the inner edge of the habitable zone of the star. Several orbits remain possible for the third planet based on our current data. The infrared brightness of the host star combined with its Jupiter-like size offer the possibility of thoroughly characterizing the components of this nearby planetary system.

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302.08 – Water loss from terrestrial planets orbiting ultracool dwarfs: Implications for the planets of TRAPPIST-1

Ultracool dwarfs (UCDs) encompass the population of extremely low mass stars (later than M6-type) and brown dwarfs.
Because UCDs cool monotonically, their habitable zone (HZ) sweeps inward in time.
Assuming they possess water, planets found in the HZ of UCDs have experienced a runaway greenhouse phase too hot for liquid water prior to entering the HZ.
It has been proposed that such planets are desiccated by this hot early phase and enter the HZ as dry, inhospitable worlds.
Here we model the water loss during this pre-HZ hot phase taking into account recent upper limits on the XUV emission of UCDs and using 1D radiation-hydrodynamic simulations.
We address the whole range of UCDs but also focus on the planets b, c and d recently found around the 0.08 $M_\odot$ dwarf TRAPPIST-1.
Despite assumptions maximizing the FUV-photolysis of water and the XUV-driven escape of hydrogen, we find that planets can retain significant amounts of water in the HZ of UCDs, with a sweet spot in the 0.04-0.06 $M_\odot$ range.
We also studied the TRAPPIST-1 system using observed constraints on the XUV-flux.
We found that TRAPPIST-1b and c can lose as much as 15 Earth Ocean and planet d -- which may be inside the HZ depending on its actual period -- may have lost less than 1 Earth Ocean.
Depending on its initial content, they could have enough water to remain habitable.
TRAPPIST-1 planets are key targets for atmospheric characterization and could provide strong constraints on the water erosion around UCDs.

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302.09 – The Effect of Carbon Dioxide (CO_2) Ice Cloud Condensation on the Habitable Zone

The currently accepted outer limit of the habitable zone (OHZ) is defined by the "maximum greenhouse" limit, where Rayleigh scattering from additional CO_2 gas overwhelms greenhouse warming. However, this long-standing definition neglects the radiative effects of CO_2 clouds (Kopparapu, 2013); this omission was justified based on studies using the two-stream approximation, which found CO_2 clouds to be highly likely to produce a net warming. However, recent comparisons of the radiative effect of CO_2 clouds using both a two-stream and multi-stream radiative transfer model (Kitzmann et al, 2013; Kitzmann, 2016) found that the warming effect was reduced when the more sophisticated multi-stream models were used. In many cases CO_2 clouds caused a cooling effect, meaning that their impact on climate could not be neglected when calculating the outer edge of the habitable zone. To better understand the impact of CO_2 ice clouds on the OHZ, we have integrated CO_2 cloud condensation into a versatile 1-D climate model for terrestrial planets (Robinson et al, 2012) that uses the validated multi-stream SMART radiative transfer code (Meadows & Crisp, 1996; Crisp, 1997) with a simple microphysical model. We present preliminary results on the habitable zone with self-consistent CO_2 clouds for a range of atmospheric masses, compositions and host star spectra, and the subsequent effect on surface temperature. In particular, we evaluate the habitable zone for TRAPPIST-1d (Gillon et al, 2016) with a variety of atmospheric compositions and masses. We present reflectance and transit spectra of these cold terrestrial planets. We identify any consequences for the OHZ in general and TRAPPIST-1d in particular. This more comprehensive treatment of the OHZ could impact our understanding of the distribution of habitable planets in the universe, and provide better constraints for statistical target selection techniques, such as the habitability index (Barnes et al, 2015), for missions like JWST, WFIRST-AFTA and the LUVOIR mission concept.

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303 – MAVEN Results and the Martian Ionosphere I

303.01 – Science highlights from MAVEN/IUVS after two years in Mars orbit

The broad capabilities of the Imaging UltraViolet Spectrograph on the MAVEN mission are enabling new science ranging from Mars' lower atmosphere up though the escaping corona. After two years in Mars orbit, the instrument has yielded insights on the Mars dayglow, season cycles, nightglow, aurora, meteor showers, clouds, solar-planetary interactions and atmospheric escape. In this presentation we will highlight several new discoveries. First, IUVS has observed a third type of aurora not previously seen at Mars, indicative of a new kind of solar-planet interaction for non-magnetized planets. Second, spatial mapping of nitric oxide nightglow reveals regions of atmospheric downwelling necessitating substantial changes to global atmospheric circulation models. Finally, a new high-spatial-resolution UV imaging mode allows unprecedented determinations of Mars' low-altitude ozone, as well as detection of clouds from nadir to limb.