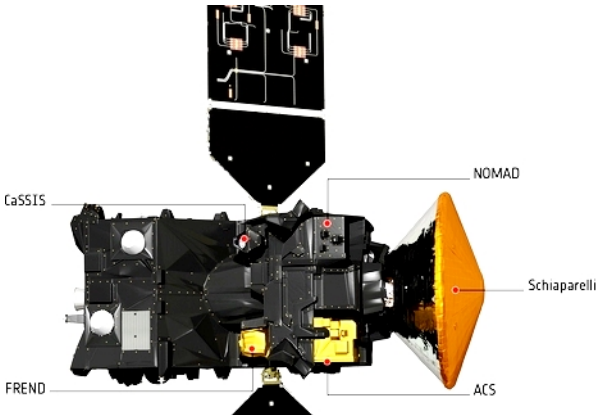
The Exomars Trace Gas Orbiter Mission: Seeking Life on Mars by **Dr Jon Mason** on 21st Oct 2016

In October 2013 Dr Dartnell of the UK Space Agency introduced us to other places in the Solar system where there might be life – Mars was one of them. Dr Mason spoke about a two stage ExoMars mission set up between the European Space Agency and the Russian Federal Space Agency to investigate life on Mars.

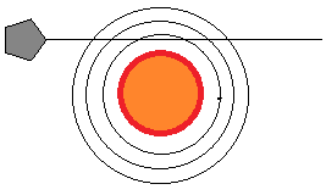
Compared to Earth, Mars is about half the diameter, surface gravity 38% and atmospheric pressure 0.6%.

Its day is about 40 minutes longer, and a year is 687 (earth) days. It has four seasons, a dynamic atmosphere, and frequent dust storms (the dust being micron sized). Its mean surface temperature is -60^{O}C, with a -140 to +35^{O}C range. It has no magnetic field (suggesting a solid core and no volcanism) and therefore no shield against cosmic rays. Its mean distance from the Sun is half as much again as Earth's.

There is water ice on the surface of Mars, but too salty to support life. Liquid water is necessary for life and may exist underground (but testing for it is banned for fear of contamination). Intense ultra-violet light and cosmic rays would preclude life on the surface, and take only 600 years to decompose methane - an important indicator of life (most methane in Earth's atmosphere is from living organisms).



Dr Mason explained the first stage of the mission: A Russian Proton rocket, launched in March 2016, ferried the Trace Gas Orbiter (TGO), to which was attached the Schiaparelli Entry, Descent & Landing module. The TGO was successfully delivered in mid-October to an elliptical orbit. The Schiaparelli module was detached a week later (in the week of Dr Mason's talk) – and became headline news when instead of a soft landing it crashed into the Martian surface. Dr Mason said landing on Mars is difficult; despite the thin atmosphere the module needed a heat shield, a parachute, and a set of thrusters for a soft landing. All these worked, but not correctly, and transmission stopped just before a crash landing. Its goal had been to measure what happened along the way to touch down, in preparation for the final mission stage, to land a rover in 2020. Despite the crash, it had sent back useful data, and investigation will add more.



While in the elliptical orbit the opportunity will be taken to use the TGO to look at Phobos and Deimos. Aerobraking by the two solar panel sails will take the TGO from its elliptical orbit to a circular 'scientific' orbit 400 km above the surface of Mars in about a year. It will then do 12 orbits per day, taking 373 orbits for complete coverage. The TGO has four instruments to map the distribution of trace gases, identify their sources and sinks, and study how they change with time:

- NOMAD, Nadir & Occultation for Mars Discovery, has three high-sensitivity spectrometers, two infrared and one ultraviolet, to identify a number of trace gasses in the atmosphere, including methane. Using the Sun as a light source, an optical grating in a spectrometer is set to measure a characteristic wavelength of a gas to be analysed – as the TGO rises from behind Mars and looks through decreasing thickness of the atmosphere.
- ACS, the Atmospheric Chemistry Suite, developed by Russia, has three infrared spectrometer channels, giving an extension to the NOMAD range.
- CaSSIS, the Colour & Stereo Surface Imaging System, is a high-resolution, 4.5m/pixel (15ft/pixel), colour stereo camera for building accurate digital elevation models of the Martian surface.

- FREND, Fine-Resolution Epithermal Neutron Detector, also Russian, will see if there is water or hydrates in the top meter of the Martian surface.

Dr Mason's interest was particularly in NOMAD. This had Belgian optics and British electronics. During its gestation there were 563 meetings. A special calibration rig was built, but an IKEA lamp was found to be better; calibration was completed at the due date – after frantic overtime – only for another part of the project to occasion a two month delay. The ideal temperature for the detector is between -40 & -60^{O}C, but they settled for -20^{O}C as a 5kg cryogenerator was deemed too heavy. However 25kg was added later in order to balance the spacecraft. The assembly had 941 hand torqued screws.

On its way to Mars it looked at Jupiter, but without result. Once at Mars (in elliptical orbit) it was aimed at the Sun - as it was designed to do (the aim has to be very steady), and as it was occulted by Mars at rising latitudes the Sun got brighter. Except for dimple – which was found to correspond with a sun spot.

A future mission in the pipeline is JUICE – JUpiter ICy moon Explorer, to look particularly at Europa, Ganymede and Callisto.