ASTEROIDAL ATMOSPHERES: A NEW SUBJECT AREA

Introduction: A few years ago the Moon was widely thought to be a dry, barren place. Today, with results from both spacecraft observations [e.g. 1] and laboratory analyses [e.g. 2], the regolith of the Moon is considered to contain a number of different forms of water at various levels of concentrations (up to % levels). Indeed, it is now commonplace to talk about a lunar hydrosphere and its associated water cycle. One component of this arises from a substance that is seen to come and go [3], known as “space dew” [4], which is most likely to be the result of an interaction between the solar wind (H) and the lunar surface (O). It is a short step to postulate that an equivalent effect would also be associated with the surfaces of asteroidal bodies. And, by extension, these would also have atmospheres (perhaps more accurately considered as exospheres, although if cycling of dew at the surface of the Moon is a reality then perhaps “exosphere” is semantically incorrect). This would be on top of the large volumes of water that are already considered to exist within the upper layers of large bodies like Ceres, and as prominent surface deposits on asteroids such as 24 Themis.

Lutetia: On 10th July 2010 the Rosetta spacecraft (ESA’s mission to rendezvous with, and land on, a cometary nucleus) flew past the asteroid 21 Lutetia. This is by far the largest such body thus far visited by a space mission and some spectacular images were obtained [5]. Amongst the investigations carried out during the flyby was a campaign mounted by various gas analysis instruments to search for evidence of an atmosphere around the asteroid. Included in this was the Ptolemy instrument, which is located on the Lander (Philae) element of the mission [6].

Discussion: Although there is not space here to describe the results from all of the Rosetta instruments it is clear that at closest approach (ca. 15,000 km, at the sub-solar point) the gas analysis instruments detected increases in signals from volatiles such as H$_2$O and CO$_2$. The question is: were these the result of the spacecraft traversing an asteroidal atmosphere, or were they somehow a result of spacecraft outgassing during the various manoeuvres that were necessary for tracking purposes during the flyby? At face value the results from Ptolemy would suggest asteroidal outgassing rates of about 5 x10$^3$ kg s$^{-1}$ (i.e. considering the entire surface of the body). In principle this is the sort of level that would be expected from an active cometary nucleus and clearly seems unlikely. However, if Rosetta had flown through a collimated outgassing feature, the globally-normalized rates would appear to be much lower. Now, it could be argued that such a coincidence is unlikely, but we should point out that some asteroids, like 596 Sheila, are known to have tails (whilst certain comets have “tails” that point towards the Sun). Furthermore, recent results regarding the presence of water on the Moon should act to remind us of how quickly and completely a paradigm can change.