Exospheres from asteroids to planets

R. Killen[1], M. Burger[2], D. Hurley[3], M. Sarantos[4], and W. Farrell[1]

[1]NASA/Goddard Space Flight Center
[2]Morgan State University
[3]Johns Hopkins University Applied Physics Laboratory
[4]University of Maryland Baltimore County

The study of exospheres can give us a handle on the long-term loss of volatiles from planetary bodies due to interaction of planets, satellites and small bodies with the interplanetary medium such as the solar wind, meteors and dust, the solar radiant flux, and internal forces like diffusion and outgassing. Recent evidence for water and OH on the Moon has spurred interest in processes involving chemistry and sequestration of volatile species at the poles and in voids. In recent years, NASA has sent spacecraft to some asteroids including Vesta and Ceres, and ESA sent Rosetta to asteroids Lutetia and Steins. OSIRIS- Rex will return a sample from a primitive asteroid, Bennu, to the Earth. It is possible that a Phobos-Deimos flyby will be a precursor to a manned mission to Mars. Exospheric particles are derived from the surface and thus reflect the composition of the body's regolith, although not in a one-to-one ratio. Observation of an escaping exosphere, termed a corona, is challenging. We therefore have embarked on a parametrical study of exospheres as a function of basic controlling parameters such as the mass of the primary object, the mass of the exospheric species, the heliocentric distance, the rotation rate of the primary, the composition of the body (asteroid type or icy body). These parameters will be useful for mission planning as well as quick-look data to determine the size and location of bodies likely to retain their exospheres and observability of exospheric species. It is also of interest to be able to determine the extent of contamination of the pristine exosphere due to the spacecraft sent to make measurements.

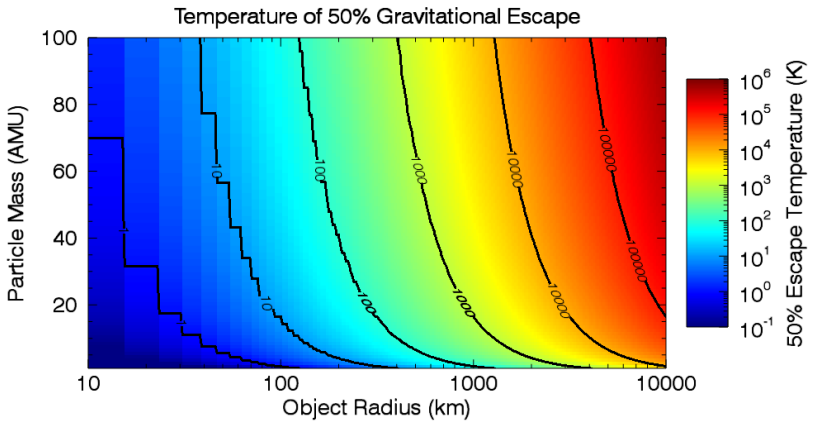

Figure: The escape temperature vs. particle mass and object radius shows that, for objects less than 100 km in radius, almost all released atoms or molecules escape gravitationally, whereas, for objects of the Earth size, almost all volatiles are retained. Intermediate-sized objects may lose light volatiles while retaining heavier particles.

Acknowledgements: The authors acknowledge funding from the DREAM2 team of the NASA/SSERVI Virtual Institute.