EGU22-10466
https://doi.org/10.5194/egusphere-egu22-10466
EGU General Assembly 2022

Collisional Evolution of the Inner Zodiacal Cloud: In-Situ observations from PSP and implications for Airless Body Surfaces

Jamey Szalay[1], Petr Pokorný[2,3], David Malaspina[4,5], Anna Pusack[5], Mihály Horányi[6,5], Michael DeLuca[1], Stuart Bale[7,8], Karl Battams[9], Claire Gasque[7,8], Keith Goetz[10], Harald Krüger[11], David McComas[10], Nathan Schwadron[12], and Peter Strub[11]

[1]Princeton University, Astrophysical Sciences, Princeton, United States of America (jszalay@princeton.edu)
[2]Astrophysics Science Division, NASA Goddard Spaceflight Center, Greenbelt, MD 20771, USA
[3]Department of Physics, The Catholic University of America, Washington, DC 20064, USA
[4]Department of Astrophysical and Planetary Sciences, University of Colorado Boulder, Boulder, CO 80309, USA
[5]Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, CO 80303, USA
[6]Department of Physics, University of Colorado Boulder, Boulder, CO 80309, USA
[7]Space Sciences Laboratory, University of California, Berkeley, CA 94720, USA
[8]Physics Department, University of California, Berkeley, CA 94720, USA
[9]US Naval Research Laboratory, 4555 Overlook Avenue, SW, Washington, DC 20032, USA
[10]School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, USA
[11]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany
[12]University of New Hampshire, Durham, NH 03824, USA

The zodiacal cloud is one of the largest structures in the solar system and strongly governed by meteoroid collisions near the Sun. Collisional erosion occurs throughout the zodiacal cloud, yet it has been historically difficult to directly measure. After transiting the inner-most regions of the solar system with Parker Solar Probe (PSP), we find that its dust impact rates are consistent with at least three distinct populations: bound zodiacal dust grains on elliptic orbits (α-meteoroids), unbound β-meteoroids on hyperbolic orbits, and a third population of impactors that may be either direct observations of discrete meteoroid streams or their collisional by-products ("β-streams"). The β-stream from the Geminids meteoroid stream is a favorable candidate for the third impactor population. β-streams of varying intensities are expected to be produced by all meteoroid streams, particularly in the inner solar system, and are a universal phenomenon in all exozodiacal disks. We discuss these recent PSP observations of the dust environment in the very inner solar system, provide constraints on their relative densities and fluxes, and discuss the erosion rate of zodiacal material.

These observations are also directly relevant for understanding the impactor and space weathering environment experienced by airless bodies in the inner solar system. Since the discovery of the Moon's asymmetric ejecta cloud, the origin of its sunward-canted density enhancement has not been well understood. Ejecta is produced from β-meteoroids which impact the Moon's sunward side at similar locations to this previously unresolved asymmetry. These small grains are submicron in size, comparable to or smaller than the lunar regolith particles they hit, and can impact the Moon at very high speeds ~100 km s^{-1}. Incorporating β-meteoroid fluxes observed by the Pioneers 8 & 9, Ulysses, and Parker Solar Probe spacecraft as a newly considered impactor source at the Moon, we find β-meteoroid impacts to the lunar surface can explain the sunward asymmetry observed by LADEE/LDEX. We discuss these observations and how this finding suggests β-meteoroids may appreciably contribute to the evolution of other airless surfaces in the inner solar system.