SAMPLING INTERPLANETARY DUST PARTICLES FROM ANTARCTIC AIR.

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Introduction: Analyses of interplanetary dust particles (IDPs) collected in the stratosphere show that these are primitive materials and that a subset, the chondritic-porous IDPs (CP-IDPs), have no meteorite counterparts. Evidence of their primitive nature includes their porous, fragile, fine-grained structures [1], highly unequilibrated chemistries and anhydrous mineralogy, high concentrations of pre-solar grains [2], the presence of amorphous silicates [3], abundant organic matter [4], and H, C, or N isotopic anomalies in the organics [5]. The CP-IDPs come from bodies that are not sampled by meteorites and are either comets or the uncompacted, unaltered surfaces of primitive asteroids. Recently, samples from melted Antarctic snow show that highly primitive materials can be collected on the Earth's surface, including CP-IDP-like grains [6], particles with affinities to Wild 2 comet grains, and rare ultra-carbonaceous particles [7,8].

We are undertaking a NASA and NSF supported project to filter large volumes of clean Antarctic air to collect a broad range of cosmic dust, including CP-IDPs, rare ultra-carbonaceous particles and comet particles derived from specific meteor streams. By routinely collecting substantial numbers of particles over known time periods, we hope to collect particles from specific comets streams, as was done in the stratosphere for comet Grigg Skellerup [9]. As the primitive particles we seek have been collected from Antarctic snow, they must also be present in the near-surface air. Filtering the air stream is a clean, cost-effective way of obtaining pristine particles.

Sampling Strategy: We will filter the air stream upwind of South Pole station from the clean air sector, using an intake 6 m above the snow surface and continuous suction speeds of 3 – 5 m/s. We selected 3-µm, track-etched polycarbonate filters as a good compromise between collection rate and pumping requirements. With a 9 kW suction pump and 20-cm diameter filter, we expect to collect 300 – 900 extraterrestrial particles larger than 5 µm each month, and 7,000 – 22,000 IDPs over two years of sampling (numbers based on measured stratospheric IDP concentrations [10]). This large, clean, and time-stamped collection will make it possible to identify systematic differences in the meteoroid complex throughout the year and to sample episodic or periodic events, e.g., meteor streams. Concurrent with the collection effort, we will characterize the particles on each filter to provide the context in which to place the very detailed information we hope to obtain from representative or unique individual particles.

If successful our samples would complement and provide advantages over Stardust Wild2 samples (collected at hypervelocity into silica aerogel) and stratospheric IDPs (usually collected in silicone oil, some of which is adsorbed in nanopores and cannot be removed). Furthermore, air filtering obviates the collection and melting of large volumes of snow, improves temporal resolution, and eliminates particle contact with water during collection, thereby preserving water-soluble or easily altered phases. Timed collections, targeted to capture materials from specific meteor streams or linked to seasonal variations in the particle flux, require only changing the filters.

References: [1] Bradley J. P. 1983. Nature, 301:473–477. [2] Messenger S. et al. 2003. Science, 300: 105–108. [3] Bradley J. P. 1994. Science, 265: 925–929. [4] Thomas K.L et al. 1993. Geochim. Cosmochim Acta, 57, 1551–1566. [5] Messenger S. 2000. Nature 404: 968–971. [6] Noguchi T., et al. 2015. EPSL, 410: 1–11. [7] Dobrica E. et al. 2009. Meteoritics and Planetary Science, 44: 1643–1661. [8] Duprat J. E. et al. 2010. Science, 328: 742–745. [9] Busemann H. et al 2009. EPSL 44–57. [10] Brownlee D.E., et al. 1977. Proc. Lunar Sci. Conf. 8th, pp 149–160.