Sears, Derek W.; Craig, J. (2006) Natural Thermoluminescence And The Radiation And Thermal Histories Of Stardust Particles. American Astronomical Society, DPS meeting #38, #29.08

Abstract

Early reports suggest that some of the particles collected from Comet Wild 2 are crystalline in nature. In this case, unique insights into their thermal and radiation history are possible through the measurement of their thermoluminescence properties. Measurements on chondrules from chondritic meteorites suggest that the thermoluminescence of grains as small as a few micrometers can be detected, provided those grains are crystalline in nature. The thermoluminescence phenomenon results from the rapid deexcitation of electrons in metastable traps. The initial population of electrons in metastable states depends on a competition between excitation by the passage of ionizing radiation through the crystals of a non-conductor and temperature-dependant deexcitation through a thermal barrier. Thus, new insights into the thermal and radiation history are possible, which relate to the history of the grains in the cometary nucleus. Particles resting on the surface (or near surface, say within a meter) will have experienced high radiation levels and high temperatures, while buried samples will have experienced lower temperatures and lower radiation levels. However, TL adjusts much faster to temperature changes than it does to changes in radiation environment, so we also expect to observe surface particles subsequently buried and recently excavated particles. The overprint of heating during atmospheric passage or while awaiting collection on the ground will be uniform for all the grains or it will relate to position in the sample return capsule, so it should be identifiable.
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