

similar to those in the inclusions of the reduced CV3 chondrites, although additional knowledge of CA1 materials in oxidized CV3s other than Allende is of critical importance to fully assess this interpretation.

**References:** [1] Simon S. B. et al. (1994) *LPSC XXV*, 1275–1276. [2] McSween H. Y. (1977) *GCA*, 41, 1777–1790. [3] Grossman L. and Steele I. M. (1976) *GCA*, 40, 149–155.

**VIDEO OBSERVATIONS OF THE PEEKSKILL METEORITE FIREBALL: ATMOSPHERIC TRAJECTORY AND ORBIT.** Z. Ceplecha<sup>1</sup>, P. Brown<sup>2</sup>, R. L. Hawkes<sup>3</sup>, G. Wetherill<sup>4</sup>, M. Beech<sup>5</sup>, and K. Mossman<sup>3</sup>, <sup>1</sup>Department of Interplanetary Matter, Astronomical Institute of the Academy of Sciences, 251 65 Ondřejov Observatory, Czech Republic, <sup>2</sup>Department of Physics, University of Western Ontario, London, Ontario, N6A 3K7, Canada, <sup>3</sup>Department of Physics, Engineering and Geology, Mount Allison University, Sackville New Brunswick, E0A 3C0, Canada, <sup>4</sup>Carnegie Institution of Washington, Department of Terrestrial Magnetism, 5241 Broad Branch Road, NW, Washington DC 20015, USA, <sup>5</sup>Department of Astronomy, University of Western Ontario, London, Ontario, N6A 3K7, Canada.

At 23:48 UT ( $\pm 1$  min) on October 9, 1992, a fireball, brighter than the full Moon, appeared over West Virginia, traveled some 700 km in a north-easterly direction, and culminated in at least one meteorite impact. A 12.4-kg ordinary chondrite (H6 monomict breccia) was recovered in Peekskill, New York. Fortunately, the event was captured on several video recordings.

Peekskill is only the fourth meteorite to have been recovered for which detailed and precise data exist on the meteoroid atmospheric trajectory and orbit. Consequently, there are few constraints on the position of meteorites in the solar system before impact on Earth. In this talk, the preliminary analysis based on 5 video recordings of this fireball (from all existing 15 video recordings) will be given.

Preliminary computations revealed that the Peekskill fireball was an Earth-grazing event, the third such case with precise data available. The body, with an initial mass of the order of  $10^4$  kg and with initial velocity of 14.7 km/s (geocentric velocity of 10 km/s) was in a precollision orbit with a = 1.5 AU, an aphelion of slightly over 2 AU, an inclination of  $5^\circ$  and an orbital revolution of 1.8 yr. The no-atmosphere trajectory over the Earth's surface would have led to a perigee of 22 km, but the body never reached this point due to tremendous fragmentation and ablation. The dark flight of the recovered meteorite started from a height of 30 km, when the velocity dropped below 3 km/s, and the body continued an additional horizontal distance of 50 km without ablation, until it hit a parked car in Peekskill, New York, with a vertical velocity of about 80 m/s.

Our observations are also the first video records of a bright fireball and the first motion pictures of a fireball with an associated meteorite. During the second half of its flight, the fireball exhibited extensive fragmentation with several dozen individual fragments visible on some video frames. A maximum simultaneous separation of fragments was  $>20$  km. At least 70 pieces are visible on two high-resolution still photographs of the event. Details on the fragmentation dynamics of the body will be presented, and the results of photometric work will be discussed.

Work is continuing on the further refinement of the atmospheric trajectory and orbit. We anticipate improvements through measurements from additional digitized video frames, more reliable positional measurements of reference objects, incorporation of data from additional stations, and better modeling of ablation and deceleration.

**ASTEROID 243 IDA AND ITS SATELLITE.** C. R. Chapman<sup>1</sup>, K. Klaassen<sup>2</sup>, M. J. S. Belton<sup>3</sup>, J. Veverka<sup>4</sup>, and the Galileo Imaging Team, <sup>1</sup>Planetary Science Institute, 620 N. 6th Avenue, Tucson AZ 85705, USA, <sup>2</sup>Jet Propulsion Laboratory, Pasadena CA 91109, USA, <sup>3</sup>National Optical Astronomy Observatories, Tucson AZ 85719, USA, <sup>4</sup>Cornell University, Ithaca NY 14853, USA.

On August 28, 1993, Galileo flew past the asteroid 243 Ida and recorded numerous pictures and other data on its tape recorder. A high-resolution mosaic of Ida, released last September, shows a highly irregular body

(roughly 56 km long), heavily covered with craters, with many interesting geological features, including grooves, blocks, chutes, dark-floored craters, and crater chains [1]. In the period February through June 1994, the remaining data have been slowly radioed back to Earth. Not all of these data will be fully analyzed or released by the time of the Meteoritical Society meeting, but several new results have been announced.

A satellite of Ida, with a preliminary designation of 1993 (243) 1, was discovered in orbit around Ida. It is approximately 1.5 km in diameter, has an albedo and spectral reflectance not grossly different from Ida, and orbits Ida in a prograde direction with a period of roughly 20 hr, assuming circular orbit (it was located about 80 km from the center of Ida during the period of observation). No other comparable-sized satellites have been found near Ida.

New pictures of the opposite side of Ida from the view released in September reveal an irregular, dog-bone shape, with a prominent gouge that seems to separate Ida into two chief components—very different from Ida's broad, monolithic appearance seen in September's view. A V-shaped valley, well shown in the highest-resolution view of Ida returned in April, may mark a modest expression on the September face of the more dramatic feature on the back side.

Ida's dense population of craters shows a wide diversity of morphologies, consistent with the surface having been subjected to saturated bombardment by smaller projectiles. Assuming the same projectile flux applies to Ida that was used in deriving Gaspra's cratering age of  $\sim 200$  m.y. [2], and assuming that Gaspra and Ida both have the same impact strength, then the age of Ida's surface is calculated to be 1–2 b.y. This is considerably older than expected from other evidence concerning the Koronis family (including interpretations of IRAS dust bands and the spins of other members of the Koronis family). Perhaps one of the aforementioned assumptions is wrong and either (1) Gaspra is compositionally stronger than Ida or (2) Ida's presence in the Koronis family somehow subjected it to an early, intense bombardment different from Gaspra's cratering environment.

Our favored explanation of Ida's satellite is that it (or a precursor satellite from which the present satellite was derived) formed during the catastrophic disruption event that formed Ida itself and formed the Koronis family of asteroids. As suggested by Hartmann [3] and Martelli et al. [4], jets in a catastrophic collision can propel objects away from the blast at nearly the same velocities and directions so that they can become captured in orbit around one another. Perhaps, instead, the satellite is a block ejected from a cratering impact; Weidenschilling et al. [5] predicted that any such satellite would be a rubble pile, much smaller than the primary, and would be found in a prograde orbit within a few radii of the primary. In any case, smaller blocks visible on some parts of Ida are more certain to be crater ejecta, whether or not they were ever temporary satellites.

**References:** [1] Belton M. J. S. et al. (1994) *Science*, submitted. [2] Belton M. J. S. et al. (1992) *Science*, 257, 1647–1652. [3] Hartmann W. K. (1979) in *Asteroids*, 466–479, Univ. of Arizona. [4] Martelli G. et al. (1993) *Astron. Astrophys.*, 271, 315–318. [5] Weidenschilling S. J. et al. (1989) in *Asteroids II*, 643–658, Univ. of Arizona.

**BORON ISOTOPE VARIATIONS IN CHONDRULES: CONSEQUENCES ON CHONDRULE FORMATION AND BORON COSMOCHEMISTRY.** M. Chaussidon<sup>1</sup> and F. Robert<sup>2</sup>, <sup>1</sup>CRPG-CNRS, BP 20, 54501 Vandoeuvre-lès-Nancy, France, <sup>2</sup>Museum d'Histoire Naturelle-CNRS, 61 rue Buffon, 75005 Paris, France.

A B isotope study of chondrules was undertaken in several chondrites (Semarkona LL3, Allende CV3, Hedjaz L3, and Estacado H6) to (1) evaluate the potential of B isotopes for constraining the mechanism of chondrule formation and (2) document the possible B isotope heterogeneity of nebular precursors and of chondrites. Measurements were made with an IMS 3f ion microprobe at CRPG (Nancy) on  $\approx 25$ - $\mu\text{m}$  spots, following the procedures developed for mantle rocks [1,2] and with careful attention paid to problems of surface contamination. Values of  $\delta^{11}\text{B}$  vs. NBS 951 ( $^{11}\text{B}/^{10}\text{B} = 4.04558$ ) are given with an accuracy varying between  $\pm 5\%$  and  $\pm 10\%$  according to the B contents. Elemental ratios of B, Na, Mg, Al, K, and Ca vs. Si were determined simultaneously on the same spots by ion probe.

Large discrepancies exist between the only two existing B isotope studies of bulk chondrites, which report three  $\delta^{11}\text{B}$  measurements between  $-35 \pm$