

# The Peekskill Meteorite and Fireball



The Peekskill Meteorite - image from [Swiss Meteorite Lab](#)

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A copy of the *Nature* paper by Brown *et al.*, on the Peekskill fall is available [here](#)

A copy of the *Earth, Moon and Planets* paper by Beech *et al.*, on the Peekskill meteorite is available [here](#)

A copy of the *Meteoritics and Space Science* paper by Th. Graf *et al.*, on the exposure history of the Peekskill meteorite is available [here](#)

Dr. Peter Brown has set up a web page of fireball videos and still images (including those for the Peekskill fireball ) at this [link](#)

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## Images, Videos and More

A photograph of the car struck by the Peekskill meteorite can be found here: [Astronomy Picture of the Day](#)

Slides taken by Dr. William Menke of the Peekskill meteorite and car shortly the fall can be found [here](#)

## **1. Introduction: the story of the fireball and meteorite.**

The events surrounding the fall of the Peekskill meteorite on October 9th, 1992 are quite remarkable. Not only did the meteorite announce its arrival by hitting a parked car in suburban Peekskill, New York, but also the fireball that proceeded the fall of the meteorite was videographed by at least 16 independent videographers.

Eyewitness accounts indicate that the fireball associated with the Peekskill meteorite first appeared over West Virginia at 23:48 UT (+/- 1 min.). The fireball, which traveled in an approximately northeasterly direction had a pronounced greenish colour, and attained an estimated peak visual magnitude of - 13 (comparable to the Full Moon). During a luminous flight time that exceeded 40 seconds the fireball covered a ground path of some 700 to 800 km (Brown et al, 1994).

The meteorite recovered at Peekskill, N.Y., (41.28 deg. N, 81.92 deg. W) had a mass of 12.4 kg and was subsequently identified as an H6 monomict breccia meteorite (Wlotzka, 1994). The video record suggests that the Peekskill meteorite probably had several companions, however, given the fireball's shallow angle of trajectory the fall ellipse is large. This fact coupled with the harsh terrain surrounds the Peekskill area would suggest that the recovery of related fragments is unlikely.

## **2. Atmospheric Flight - gross characteristics:**

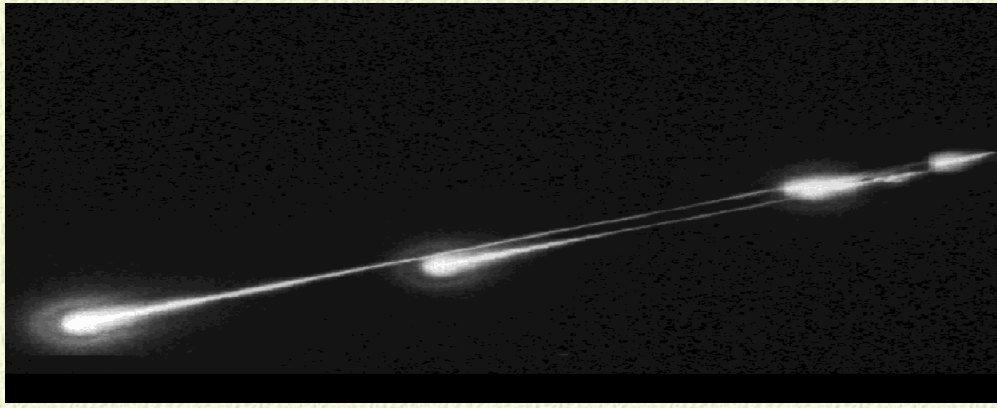
To date 16 videographic tapes showing the Peekskill fireballs passage through the Earth's atmosphere have been collected. It is our belief that more videos of this event probably exist - and we would welcome new observations.

An analysis of the fireball's atmospheric flight has been made from four of the 16 videos collected (Brown et al., 1994) At the beginning of the video record the meteoroid's velocity and height were 14.7 km/s and 46.6 km respectively.

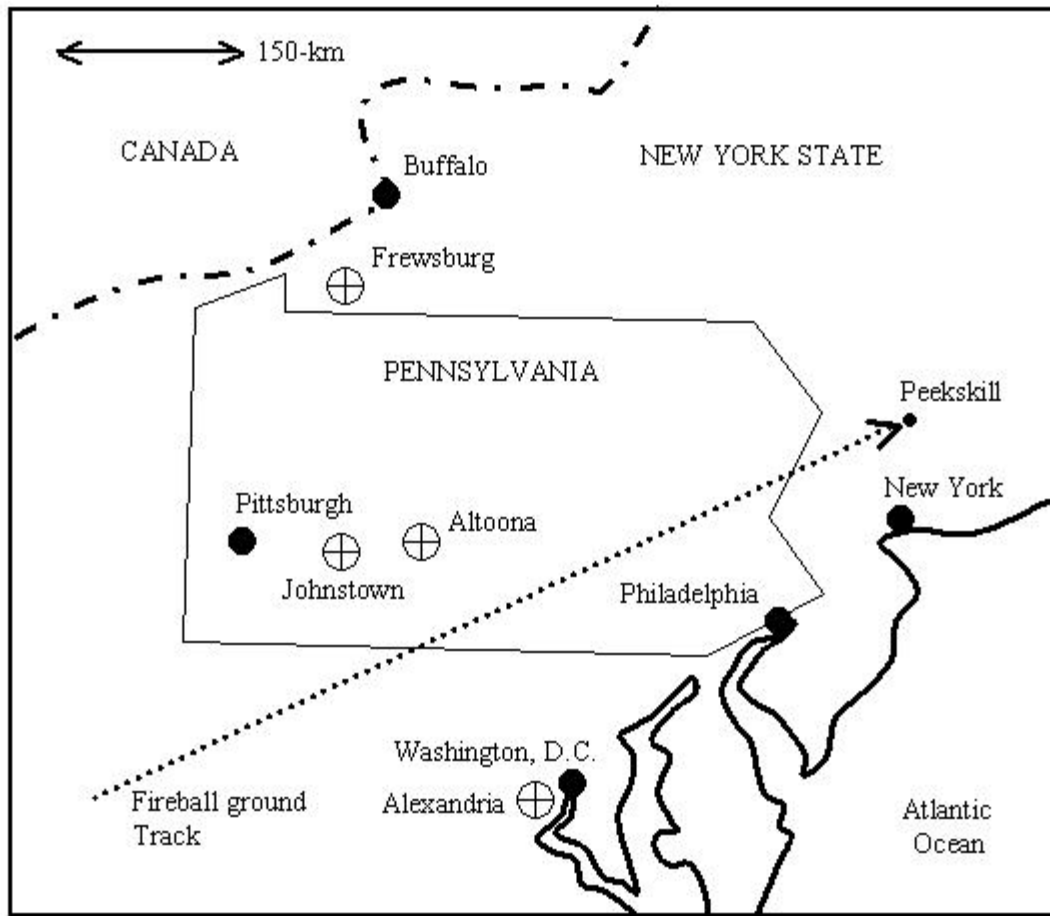
At a height of ~ 41.5 km extensive fragmentation of the main meteoroid body took place. Differential aerodynamic drag subsequently caused a significant (greater than 20 km) longitudinal displacement of the fragments. A transverse displacement amounting to ~ 1km also developed in some smaller fragments. A dynamical mass of order 20 - 25 metric tons is inferred for the parent meteoroid. Radioisotope studies of the Peekskill meteorite (Graf et. al., 1994) suggest that the parent meteoroid had an initial radius somewhere between 50 and 100 cm. Spherical objects of this size would have masses between ~2 and 15 metric tons.

Prior to the main fragmentation event the video observations indicate a significant wake behind the main body of the fireball. A distinctive 'flickering' is also apparent in the wake, and periodic disconnection events take place with an average frequency of 6 Hz. The disconnection events may be due to the rotation of the parent body, or they may reflect a hydrodynamic instability in the wake - ambient boundary.

In addition to the wake flickering phenomena, and the fragmentation event, the video record also shows two, time-resolved flares. The most pronounced flare occurred at a height of ~ 36.4 km and lasted for just 1/3rd of a second. An investigation of the grain sizes that might produce the required lag (~3km behind the leading body) and flare duration indicate the ejection of about 1000 grains each of mass 1g.



**The Peekskill fireball.** This photograph, taken by S. Eichmiller in Altoona P.A., was taken after the catastrophic fragmentation of the main meteoroid body. Note the large transverse displacement of the smaller fragments.



⊕ = location where simultaneous sounds reported

**Ground path of the Peekskill fireball and locations where simultaneous (electro-phonetic) sounds were reported from.**

### 3. Atmospheric Flight - electro-phonetic sounds:

While we were not primarily concerned with collecting eyewitness accounts of the fireball that proceeded the Peekskill fall, we did receive many unsolicited reports and some of these noted the presence of electrophonic sounds.

The most detailed account that we received was that by Patsy Keith and family who observed the fireball from a car near Altoona, Pennsylvania. The sound was described as a "crackling sound like that of a sparkler." The sound lasted for about 10 seconds and was audible for several seconds after the first major fragmentation event.

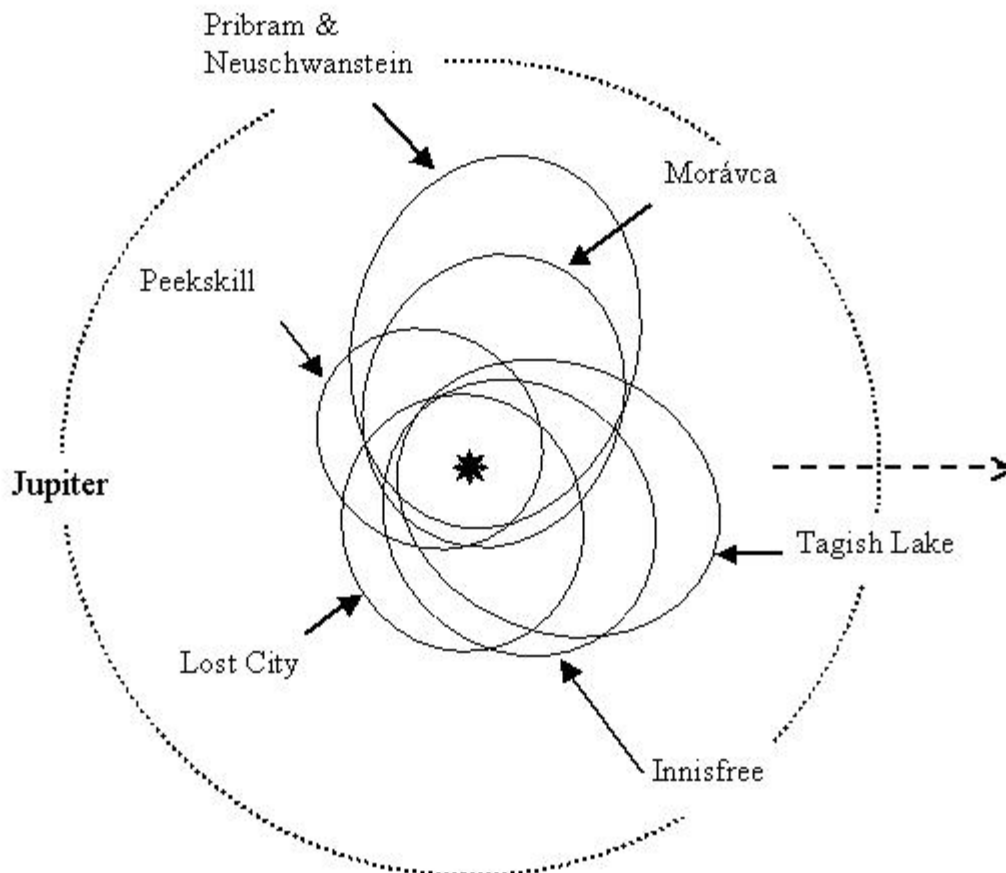
#### 4. Orbit of Parent Body:

The Peekskill meteorite is the fourth meteorite in history for which there is a known orbit. The orbital parameters are given below. The parent body of the Peekskill meteorite had an aphelion distance of 2.1 au, which indicates that it was periodically placed at the inner edge of the main asteroid belt.

Orbital Parameter	Reduced Value	Error Terms
Semimajor axis	1.49 AU	0.03 AU
Eccentricity	0.41	0.01
Perihelion distance	0.886 AU	0.004 AU
Argument of perihelion	308 deg.	1 deg.
Long. ascending node	17.030 deg.	0.001 deg
Inclination	4.9 deg.	0.2 deg.
Orbital period	1.82 yr	0.05 yr.

**Table. Orbital parameter for the Peekskill meteoroid before Earth impact.**

The errors terms are +/- 2 times one standard deviation. The factor of 2 is introduced to allow for the possibility of uncorrected systematic errors.



Comparison of known meteorite orbits

**The diagram shows the orbit of the Peekskill meteorite along with the orbits derived for several other meteorite falls. The dashed line from the center is in the direction of the Vernal Equinox.**

The parent body of the Peekskill meteorite encountered the earth 41 +/- 1 days after its last perihelion passage. The Earth-meteoroid encounter geometry was such that had the meteoroid been ~ 40km higher at perigee it would have skimmed through the Earth's atmosphere and returned to space.

### 5. Final Remarks:

The video observations of the fireball, which preceded the fall of the Peekskill meteorite, have provided a great wealth of hitherto unavailable data. The high-time resolution, and multi-station aspect of the collected video data has enabled us to study in unprecedented detail the passage of a large meteoroid through the Earth's atmosphere. Our study of this most interesting event continues.

### 6. References:

- Brown, P. (+ consortium), 1994. *Nature*, 367, 6524 - 626. (Original results presented in this paper)
- Beech, M. (+ consortium), 1995, *Earth, Moon and Planets*, 68, 189 - 197. (Up-date of work since first paper)
- Graf, Th. et. al., 1994. *Meteoritics*, 29, 269 - 470.
- Wlotzka, F. 1994. *Meteoritical Bull. # 75, Meteoritics*, 28, (5), 692.

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*Page maintained by Martin Beech. last modified November 27th, 2006.*