Daylight Fireball of August 10, 1972

By Gary W. Kronk

A very bright daylight fireball appeared in the skies of the western United States and Canada on August 10, 1972. It was seen by a large number of people, most notably many camera-bearing tourists located in Grand Teton, Yellowstone, and Glacier national parks. In addition, the object became hot enough to also be detected by a U. S. Air Force satellite-borne near-infrared radiometer.

The object was detected by visual observers at around 20:30 UT. Eyewitness accounts came from Utah, Wyoming, Idaho, Montana, and Alberta, with many photographs and two 8-mm films obtained. Linda Baker was then at Jackson Lake, which is at the foot of the Grand Tetons. After spotting the bright object and the following dust trail over the Tetons, she began filming with a Super-8 camera. Her film recorded the object's south-north movement across the sky for 26 seconds. She and her husband thought the object was a rocket re-entry. The satellite recorded the object from 20:28:29 until 20:30:10 UT.

Although a few newspapers reported the event, the first major publication came in *Sky and Telescope* during October 1972, which was basically a collection of eyewitness accounts. During April 1973, details of the satellite observation were published in *Sky and Telescope*, with a more comprehensive article appearing in *Nature* on February 15, 1974.

The first significant analysis of this fireball was published in *Sky and Telescope* during July 1974. It was written by Luigi G. Jacchia, a meteor expert at the Center for Astrophysics in Massachusetts, who just happened to witness the fireball from Jackson Lake Lodge in the Grand Tetons. Jacchia said he was initially impressed by the extraordinarily long 1,500 kilometer length of the object's path. He also pointed out that at the mid-point of the path sonic booms were heard in Montana and said this indicated the object was lower than 60 kilometers. The fact that sonic booms were not heard over Alberta was considered puzzling. With the object moving northward, one would expect it to have continued to lower, so that sonic booms should have continued and an impact was likely. No reports of impacts existed. Jacchia concluded that the object must have "entered the earth's atmosphere at a very small angle to the horizontal, reached a minimum height of less than 60 kilometers above Montana, and continued

its flight without impacting." Jacchia found out about the Air Force satellite detection around the time of his initial analysis and at his urging the information was finally released. Jacchia's analysis revealed the object first became hot enough to be detected by the Air Force satellite at a height of 76 kilometers over Utah. Its closest distance to Earth was 58 kilometers, which occurred over Montana. As it continued its passage through the atmosphere it finally cooled below the satellite detection level at a height of 102 kilometers over Alberta.

Jacchia gave the available data to Richard McCrosky of the Smithsonian Astrophysical Observatory, who was able to compute the initial orbit of this fireball. The object would have reached its perihelion distance of 1.01 AU about four days after the encounter with Earth's atmosphere. The semimajor axis was given as 1.66 AU, the orbital inclination was 15°. Jacchia stated that the encounter changed the orbit of the object, but no details were given.

The first estimates of the object's mass were made by C. D. Bartky *et al.* in a *Nature* article of February 15, 1974. They indicated a value of 1000 metric tons, which they said corresponded to a diameter of 4 meters for an object the density of iron. They determined that the impact of such an object would have released energy equivalent to the nuclear bombs dropped on Hiroshima and Nagasaki. Jacchia later corrected the size estimate made by Bartky et al. to 6 meters, but stated these estimates, which were based on the rate of deceleration through the atmosphere, could not sufficiently indicate the object's true mass and size. Jacchia approached the problem from the standpoint of the object's brightness. Taking magnitude estimates of -15 and -19 when about 100 kilometers above Earth, he estimated the mass as 4000 to 1 million metric tons. He added that since most meteors are stoney and not iron, the probable size would have ranged from 13 to 80 meters.

Although a few other papers were published during the next 20 years which basically revised some of Jacchia's work, the next major paper discussing this fireball was written by Zdenek Ceplecha for *Astronomy and Astrophysics* in 1994. Ceplecha revised almost every aspect of Jacchia's analysis, including the mass and orbit. He even determined the post-encounter orbit. Ceplecha believed the likely diameter of the object would have been 3 meters, if a carbonaceous chondrite, or as large as 14 meters, if composed of cometary materials, prior to the encounter. He suggested the likely mass loss suffered from the encounter would make the mass two to three times less than the initial mass. This indicated a post-encounter mass of 2 or 10 meters.

The pre-encounter orbit was close to that published by Jacchia and was as follows:

Semimajor Axis=1.661±0.004 AU
Eccentricity=0.3904±0.0016
Perihelion distance=1.0127±0.000 AU
Aphelion distance=2.310±0.009 AU
Argument of Perihelion=355.57°±0.08°

Ascending Node=317.956°
Inclination=15.22°±0.03°

The post-encounter orbit was given as follows:

Semimajor Axis=1.4715±0.0009 AU
Eccentricity=0.3633±0.0004
Perihelion distance=0.9369±0.000 AU
Aphelion distance=2.0061±0.0019 AU
Argument of Perihelion=315.76°±0.02°
Ascending Node=317.949°
Inclination=6.928°±0.012°

Ceplecha also determined a radiant for the post-encounter orbit in case any debris was travelling along with this object. The coordinates were given as RA=155.538°, DEC=-19.05°.

Ceplecha ended his paper with a prediction. He determined that it was very likely that this object would again come close to Earth within the period of 1997 July 30 to August 16, "with August 8 being the most probable date." He pointed out that if the crossing date was August 11, Earth would be in the same place and some encounter was possible.

References:

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