THE PARENT BODIES OF OUR METEOR SHOWERS. P. Jenniskens, SETI Institute, 515 N. Whisman Road, Mountain View, CA 94043 (pjenniskens@mail.arc.nasa.gov).

Introduction: Given that most of our meteor showers used to have no parent bodies, it was long concluded that most of our showers were very old and their parent comets had long decayed. In recent years, that picture has completely changed. The recent NEO surveys have found a number of minor planets that are still among the meteoroids. We now understand that many of our strongest short-period meteor showers are less than 2,000 years old. The showers trace to now dormant comet nuclei. A fragmentation mechanism is implicated [1].

Dynamical classes: Jupiter's dominant influence on the dynamical evolution of meteoroid streams is responsbile for four different types of evolutions:

a) *Long Period type*, where the orbit is so long that the perturbations by Jupiter change the return date dramatically and the meteoroids do not remember where Jupiter was in the previous orbit. The one-revolution dust trail develops normally, but the perturbations are such that the two-revolution trail is distorted and dispersed. Example: the Aurigid shower that caused the September 1, 2007, Aurigid outburst. The outburst was predicted and successfully observed in an airborne observing campaign [2].

b) *Halley type*, where the comet returns with a memory of where Jupiter was in the previous orbit. Interactions with Jupiter are weak and orbits are relatively stable. The dust trails from individual returns can be recognized for many revolutions, which can lead to multiple meteor storms when crossed. Streams build up over long periods of time, resulting in massive streams, over such a long period of time that their parent body may have evolved now quite far from Earth's orbit. Example: the Leonid showers, with new results from 2006 ground-based observations, showing the absence of fluffy particles in the tail of trails [3]

c) *Jupiter-family type*, where the comet and meteoroids are close to Jupiter at aphelion, where they move slowest. The cross section of the trail is a function of the time of ejection; the spreading of dust along the trail is enhanced. Dust trails tend to break into "trailets", and orphan trails are formed. Dust is dispersed quickly, along a nutation cycle caused by the rapid rotation of the nodal line. Example: Quadrantid shower, now associated with minor planet 2003 EH1. To determine its age, the shower was studied in an airborne mission on January 4, 2008 [4].

d) *Encke-type*, where aphelion is far inside Jupiter's orbit and the body interacts with the terrestrial planets. Dust is dispersed slowly, along a nutation cycle caused by the rapid rotation of the nodal line. Example: Geminids, associated with minor planet 3200 Phaethon.

Parent bodies: Until very recently, close associations between meteoroid streams and NEO were limited to the case of the Geminids and Phaethon. Other associations were much more loose and the stream was considered old, now far evolved from the parent body.

The recent NEO surveys have produced a large number of minor planets in orbits that now pass close to Earth's orbit, or used to do so in the recent past.

Following the October 2003 discovery that 2003 EH1 moves among the Quadrantids, very quickly other minor planets have been identified as likely parent bodies. Those include 2005 UD (Sextantids), 2003 WY25 (Phoenicids), 2002 EX12 (alpha Capricornids), 2002 XM35 (N. chi Orionids), 2004 TG10 (N. Taurids), and the Marsden and Kracht Sungrazers (Arietids and delta-Aquariids, respectively). Some of these were since shown to be weakly active comets when at perihelion (2003 WY25 and 2002 EX12).

The main obstacles to establishing more certain associations are the unknown physical properties of the newly discovered NEO and the uncertain nature of ecliptic meteor showers. A working list of target NEO has been assembled that deserve further study [5].

The IAU has now formalized the nomenclature of meteor showers and has established a task group to identify what meteor showers are real [6].

Many other associations are possible. In an effort to identify space mission targets of interest, the association of known meteoroid streams with NEOs was investigated. In addition to updating previous searches to include NEO discovered up to January 1, 2007, a new dissimilarity criterion based on the dynamical arguments was formulated and applied to evaluate the likelihood of each candidate association [5].

The formation mechanism remains under investigation. A form of fragmentation created these streams, rather than the gradual ejection of meteoroids by the drag of water vapor. The breakup of 3D/Biela was investigated to determine the nature of the dust we detected as Andromedis in 1872 and 1885 [7].

References: [1] Jenniskens P. (2006) *Meteor Showers and their Parent Comets, Cambridge University Press, 790 pp*. [2] http://aurigid.seti.org. [3] Jenniskens et al. (2008) Icarus (in press). [4] http:// quadrantid.seti.org . [5] Jenniskens P. (2008) *Icarus 194*, 13. [6] http://www.ta3.sk/IAUC22DB/MDC2007/. [7] Jenniskens P., Vaubaillon J. (2007) *AJ 134, 1037.*