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# Unraveling the Origins of JFC-like Bodies: A Comparative Study of Comets and Meteoroids

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Jupiter-family comets (JFCs) originate from the Kuiper belt and scattered disk, characterized by short orbital periods and frequent interactions with Jupiter. Their icy composition and a chaotic transition to the inner solar system result in short dynamic and physical lifetimes. These features make JFCs key subjects for understanding the migration of celestial bodies and possibly the delivery of organic materials to the early Earth. Numerous studies of fireballs have historically posited a substantial contribution of large objects from JFC orbits, suggesting a significant presence of cometary material in the near-Earth environment. However, this prevalent belief necessitates a thorough re-examination, as the physical evolution of comets and the mechanisms governing their disintegration remain subjects of debate. Understanding the population of meteoroids and comets is crucial for evaluating this population's physical breakdown and evolution. Current dust models suggest that fragmentation and disintegration of comets play a significant role in populating the zodiacal cloud. However, the larger centimeter-meter scale debris observed by fireball networks has been shown to resemble more asteroidal sources dynamically, indicating that comets might be breaking down directly only into dust-sized fragments.

This study extends the scope of existing research by conducting a detailed analysis of both JFCs and comet-like fireball observations, aiming to elucidate the origins and dynamics of objects on JFC-like orbits across varying size scales. Utilizing extensive data from four major fireball networks (DFN, EFN, FRIPON, MORP) and ephemeris data of JFCs, the research comprises 646 fireball orbits and 661 JFCs. Methods include orbital stability analysis over 10,000 years, Lyapunov lifetime estimation, debiased NEO model source region estimation, meteorite fall identification, and meteor shower analysis.

The analysis reveals that most meteoroids on JFC-like orbits do not align dynamically with typical JFCs. Instead, they predominantly originate from stable orbits in the outer main asteroid belt, challenging the notion that centimeter-to-meter scale meteoroids on JFC-like orbits primarily derive from JFCs. Furthermore, a subset of 24 JFCs in near-Earth orbits displayed unexpected

orbital stability, suggesting a presence of asteroidal interlopers from the outer main belt within the JFC population.

Our study demonstrates significant dynamical differences between kilometer-scale JFCs and smaller meteoroids. While the larger JFCs frequently encounter Jupiter and have dynamic, transient orbits, the smaller meteoroids detected by fireball networks originate primarily from stable orbits, indicating a predominant influence of asteroidal material from the outer main belt. This finding challenges conventional assumptions about the origins of JFC-like debris observed on Earth and highlights the complexity and diversity of the small-body environment in our solar system.