A tight spectroscopic quadruple as a possible progenitor of sub-Chandrasekhar Type Ia supernovae

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Stars often form in multiple systems and may follow a complex evolution involving mass transfer and collisions, leading to mergers that are possible progenitors of Type Ia supernovae (SN). Binaries have received much attention as possible progenitors of such explosions, but long-term gravitational effects in tight triple or quadruple systems could also play a key role. I will present the properties of the first spectroscopic quadruple (SB4) found within a star cluster: the 2+2 hierarchical system HD 74438. Its membership in the open cluster IC 2391 makes it the youngest (43 My) SB4 discovered so far and among the quadruple systems with the shortest outer orbital period. The eccentricity of the 6 y outer period is 0.46 and the two inner orbits, with periods of 20.5 d and 4.4 d, and eccentricities of 0.36 and 0.15, are not coplanar. Using an innovative combination of ground-based high resolution spectroscopy and Gaia/Hipparcos astrometry, we show that this system is undergoing secular interaction that likely pumped the eccentricity of one of the inner orbits higher than expected for the spectral types of its components. We compute the future evolution of HD 74438 by considering gravitational dynamics, stellar evolution, and binary interactions, and show that this system is an excellent candidate progenitor of sub-Chandrasekhar Type Ia supernova through white dwarf mergers. This specific type of SNIa better accounts for the chemical evolution of iron-peak elements in the Galaxy.