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# Binary asteroids and doublet craters on Mars

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Planetary surfaces not protected by dense atmospheres suffered by many impacts by asteroids and comets, leaving craters as a reminders of it. Among all craters observed on surfaces of Earth [1], Mars [2, 3], Moon [4, 5], and Venus [4], about 3—4% are *doublet* craters. It is believed they formed by the simultaneous impacts of the two components of binary asteroid systems. The ever-growing interest in impact deflection, and the upcoming NASA DART and ESA HERA missions to the binary asteroid (65803) Didymos, highlights the importance of understanding the population of binary asteroids, and the outcomes of binary impacts. The deflection strategies for a binary system are indeed different than for singleton, and a proper understanding of the distribution of binary asteroids is important.

Binary asteroids represent 15% of near-Earth asteroids [6], apparently at odd with the rate of doublet craters on planetary surfaces. Miljković et al. [7] showed with 3-D hydrocode simulations that only a fraction of impacts by binary asteroids create distinguishable doublet craters, solving the apparent discrepancy with the fraction of doublet craters of 3–4%. However, the few doublet crater examples in [7] have striking properties: nearly similar size and North-South orientation, unexpected from a population of binary asteroids displaying a typical size ratio of 0.3 and with a mutual orbit closely aligned with the ecliptic.

We thus conduct a survey for doublet craters on the Martian surface. We are therefore surveying double craters on the Martian surface. Our study focuses on craters more than 2 km in diameter located between latitudes 50°N and 50°S. We chose this minimum diameter in order to remove potential bias

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that could be caused by secondary impacts and this range of latitude in order to avoid the resurfacing processes occurring around the poles. Our classification, based on the morphology of the impact craters is divided into 6 categories: Elliptical, Peanut, Doublet, Tear drop, Overlapping, Circular. The last category represents craters whose double character can be ruled out. In parallel, we conduct three-body dynamical simulations to predict the orientation or doublet craters on Mars surface as inferred from the known population of binary asteroids, extending the previous work by Melosh and Stansberry [1] who had found that binary physical separation was not significantly affected by tidal forces.

We will report on the crater survey, describing the properties of crater size ratio, separation, and orientation. We will discuss how it compares with our dynamical simulations, and what the population of doublet craters on Mars teach us about the population of binary asteroids.

**Comments:**
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