NORTHERN ARIZONA UNIVERSITY

Department of Astronomy and Planetary Science

ASTRONOMY COLLOQUIUM

DAVID NESVORNY
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David Nesvorný earned his degree from Charles University in Prague and completed his doctorate at the University of São Paulo in Brazil. He is currently a researcher at the Southwest Research Institute in Boulder, Colorado, USA. Dr. Nesvorný specializes in the formation and dynamical evolution of planets and small bodies in the Solar System. He has developed a gravitational collapse theory that explains the high occurrence of equal-sized binary systems in the Kuiper Belt and has pioneered techniques to determine the formation ages of collisional families in the asteroid belt. More recently, he introduced a new physical model for the population of near-Earth asteroids. Throughout his career, Dr. Nesvorný has received numerous honors, including the prestigious Urey Prize from the Planetary Science Division of the American Astronomical Society in 2005. He has co-authored over 300 peer-reviewed publications.

WHEN:

Monday, March 30th,
3:45 PM

WHERE:

Physical Sciences,
Bldg. 19,
Room 103

TERRESTRIAL PLANET FORMATION FROM TWO SOURCE RESERVOIRS

This talk presents new dynamical simulations of terrestrial planet formation. The simulations started at the protoplanetary disk stage, when planetesimals formed and accreted into protoplanets, and continued past the late stage of giant impacts. We explored the effect of different parameters, such as the initial radial distribution of planetesimals and Type-I migration of protoplanets, on the final results. In each case, a thousand simulations were completed to characterize the stochastic nature of the accretion process. In the model best able to satisfy various constraints, Mercury, Venus, and Earth accreted from planetesimals that formed early near the silicate sublimation line at ~0.5 au and migrated by disk torques. For Venus and Earth to end up at 0.7-1 au, Type-I migration had to be directed outward, for example as the magnetically driven winds reduced the surface gas density in the inner part of the disk. Mercury was left behind near the original ring location. We suggest that Mars and multiple Mars-sized protoplanets grew from a distinct outer source of planetesimals at 1.5-2 au. While many migrated inwards to accrete onto the proto-Earth, our Mars was the lone survivor. This model explains: (1) the masses and orbits of the terrestrial planets, (2) the chemical composition of the Earth, where ~70% and ~30% comes from reduced inner-ring and more-oxidized outer-ring materials, and (3) the isotopic differences of the Earth and Mars. It suggests that the Moon-forming impactor Theia plausibly shared a similar isotopic composition and accretion history with that of the proto-Earth.