CONSTRAINING THE EARLY ASTEROID BELT K. J. Walsh[1] [1]Southwest Research Institute, 1050 Walnut St Suite 300, Boulder, CO 80302, USA (kwalsh@boulder.swri.edu)

Introduction: Models of inner Solar System formation and evolution have struggled for decades to adequately and consistently produce reasonable analogs of our Terrestrial Planets. Now, a handful of models utilizing a wide range of evolution scenarios – migrating planets or accretion directly from cm-sized pebbles – can regularly produce the planets, but diverge on their implications for the early evolution in the Asteroid Belt. Tracking down the collisional history of the asteroid belt can thus help constrain our understanding of the planet formation processes. Looking at today's asteroid belt, and meteorites derived from its population, constraints and can be built for evolution models.

Planetesimals and Planet Formation: Models of planet formation were once nearly independent of planetesimal formation – they all started from a population of ~100-ish km planetesimals regardless of how they formed. Now, dynamical models have shown that the cm-sized building blocks ("pebbles") of planetesimals can also serve to jump-start planet formation and build planetary embryos very rapidly [1]. While such speedy growth is *very* important for the Giant Planets, it is less clear what problems this can solve for the inner Solar System and all of the implications [2,3].

The Asteroid Belt: Simply looking at the physical and orbital properties of today's asteroid belt can provide severe constraints for the evolution of the inner Solar System. With a total mass orders of magnitude below that expected from smooth distributions of solids, dynamically excited orbits filling nearly all stable phase space and overlapping distributions of taxonomic types of bodies, the current asteroid belt is a total mess of information.

Previous works analyzing the integrated effects on the size frequency distribution and total mass loss find that the Asteroid Belt could have been substantially larger in the past [4]. However, there are numerous implications to grinding away different amounts of mass over the history of the Asteroid Belt.

Asteroid Families: Grinding away a huge primordial asteroid belt implies a huge amount of collisions – including lots of big ones. We see remnants of this process in large asteroid families and they can trace some of the collisional history of asteroid belt – but our ability to detect them decreases going further back in time, and is potentially completely frustrated by the Solar System dynamical re-shuffling associated with the Giant Planet instability (whenever it occurred).

Remnants of the collisions in the gas disk: Similarly a large primordial asteroid belt, depending on when it was dynamically excited, may have started experiencing collisions when the gas disk was still around [5]. These collisions have long been pointed too as possible ways to form some types of chondrules [6].

Tracing the Collisional History: Here we focus on the implications for the primordial asteroid belt mass and dynamical excitement for different flavors of terrestrial planet formation models. These implications are then confronted with the constraints from the Asteroid Belt. In particular two recent studies will utilized- the first focuses on the Asteroid Belt dynamical excitement required to form CB Chondrites [5]. Here, the need for a high-velocity collision between two large bodies (~100's km) in the presence of the gas disk pushes formation models to dynamically excite the Asteroid Belt *very* early, which is difficult to do in the absence of interference by the Giant Planets.

Second, the history of the Asteroid Belt seen through the population of Asteroid families shows relatively frequency large collisions in the last ~Gyr, but inability to detect very old families muddies the history back 3-4 Gya [7]. In a new work very old families are hunted using a new technique with a possibility to debias our catalog of families over time and constrain the Asteroid Belt mass over time [8].

References:

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