I-Xe constraints on accretion and collisional timescales

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The I-Xe system is based on the decay of ^{129}I to ^{129}Xe with a half life of 16 Myr [1] [2]. While both elements are volatile and so depleted in the solid phasein the early solar system, xenon is substantially less readily incorporated into minerals, so the high I/Xe ratios required for chronological measurements pertain even in what appear to be high temperature samples. The I-Xe system has been calibrated against the (uncorrected) Pb-Pb system via the correlation in apparent ages observed across a range of samples [3].

Constraints on the timescales for accretion may be (i) gained from the earliest ages of individual clasts and chondrules extracted from primitive meteorites or (ii) inferred from the earliest ages of achondritic samples. The I-Xe age for Ibitira is consistent with the Pb-Pb age [4]. The earliest I-Xe ages of clasts and chondrules from chondrites corresponed to 4567 Myr [5] [6]. In the case of chondrules it is debatable whether this represents chondrule formation or parent body (re)setting of the system. However, individual clasts of either igneous or shock origin appear to require the prior existence of planetesimas for their production.

The range of I-Xe ages observed in chondrules from the most primitive meteorites has long been considered to be inconsistent with their exclusively recording chondrule formation. In the absence of other plausible processes, it seems likely that processes related to impact events were responsible for setting or resetting the clock. It is apparent that chondrules that are now adjacent were reset in distinct events separated by millions of years before assembly into the rock in which they now reside. It is thus possibe that that they provide an insight into the decline of the impact rate as the solar system debris disk dissipated. A simple model based on the most extensive available dataset (that of the meteorite Chainpur [5] [7]) indicates that the collision rate in the asteroid belt declined as $t^{-1.7}$ over the first ~60 Myr of solar system evolution.

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