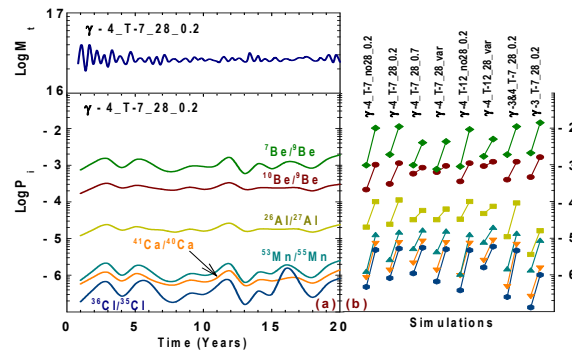


### PRODUCTION OF SHORT-LIVED NUCLIDES BY MAGNETIC FLARING IN THE EARLY SOLAR SYSTEM.

S. Sahijpal and P. Soni. Department of Physics, Panjab University, Chandigarh, India 160014. sandeep@pu.ac.in

**Introduction:** Presence of  $^7\text{Be}$  in the early solar system [1] indicates intense magnetic flaring activity associated with the proto-sun or its accretion disc. Continuing our attempts to numerically simulate evolution of proto-CAIs and their irradiation in the reconnection ring [2], we have included  $^7\text{Be}$  production.

**Methodology:** Simulations were extended for 2 decades and were refined by incorporating constant mass accretion rates ( $M_i$ ; monitored @ 100 days) by the reconnection ring. In addition to the flares with  $L_x \sim 10^{29-32}$  ergs/s [2], we irradiated grains throughout the reconnection ring by flares with  $L_x \sim 10^{27-28}$  ergs/s for timescales comparable to  $10^{29-32}$  ergs/s flares. Finally all the grains were thermally processed, *homogenized* and irradiated at the end of simulations by ‘superflares’ [3] with  $L_x \sim 10^{33}$  ergs/s for couple of hours ( $\sim 1$  hour for  $L_x \sim 10^{34}$  ergs/s flare). In addition to previous grain coagulation models [2], we tried models ‘var’, where small sized grains are preferentially ‘accreted’ by larger.



**Fig.1.** a) Evolution of the average production rates ‘P<sub>i</sub>’ of radioisotopes &  $M_i$  for the model [  $-4(dE/dN-E)_T-7$ (Flare timescales: 1-7 hours/day) $_28(L_x \sim 10^{27-28}$  ergs/s. flares included) $_0.2$ (Coagulation %)]. b) Results for the various models. Lower and the upper ends of the lines represent average production rates without and with ‘superflare’ contributions, respectively, at the end of simulations.  $^3\text{He}/\text{H} \sim 0.3$ .

**Results and Discussions:** Average production rates remain constant over time except for small deviations essentially due to variations in  $M_i$  (fig. 1). The inferred spread in the production rates among the various processed grains are at least two orders of magnitude and can yield canonical values for the radioisotopes only if we anticipate ‘superflares’ that can thermally re-process and homogenize their compositions at the end of their processing in the reconnection ring. Superflares may also be essential for the required production of  $^7\text{Be}$ . In fact these intense flares could alone produce all the radioisotopes without significant contribution from the x-wind scenario thereby avoiding close encounters of CAIs and chondrules with the proto-sun. These intense flaring events, generally associated with accretion disc [3], could be responsible for all the irradiation effects observed in meteorites and the thermal processing of CAIs and chondrules in accretion disc.  $^{41}\text{Ca}$  production is high in impulsive flare simulations and its observed abundances would require late-stage secondary alterations of CAIs. In general, all the gradual/impulsive flare simulations produce  $^9,^{10}\text{Be}$ ,  $^{53}\text{Mn}$ ,  $^{36}\text{Cl}$ . Other than stellar nucleosynthesis (essential for  $^{60}\text{Fe}$ ),  $^{26}\text{Al}$  &  $^{41}\text{Ca}$  production require impulsive flares.

**Acknowledgements:** This work is supported by ISRO (PLANEX) grant.

**References:** [1] Chaussidon M. et al. 2004. Abstract #1568. 35<sup>th</sup> Lunar & Planetary Science Conference. [2] Sahijpal S. & Soni P. 2004. Abstract #1206. 35<sup>th</sup> Lunar & Planetary Science Conference. [3] Grosso N. et al. 1997 Nature **387**, 56-58.