THE MEANING OF IRON 60: A NEARBY SUPERNOVA INJECTED RADIONUCLIDES INTO OUR SOLAR SYSTEM. S. J. Desch, N. Ouellette, and J. Hester. 1Department of Physics and Astronomy, Arizona State University., Tempe AZ E-mail: steve.desch@asu.edu.

Introduction: The recent discovery that the early Solar System contained the short-lived (t_{1/2} = 1.5 Myr) radionuclide $^{60}$Fe at a level $^{60}$Fe / $^{56}$Fe $\approx 5 \times 10^{-7}$ [1,2] demands a stellar nucleosynthetic source, almost certainly a supernova. Astronomically, the most plausible time and place for the supernova is < 1 pc away, ~ 1 Myr after the Solar System’s protoplanetary disk had formed.

Sources of Radionuclides: Possible sources of radionuclides are: inheritance from our molecular cloud material, in which some radionuclides are maintained in steady state abundance by continuous Galactic nucleosynthesis; production within the Solar System by energetic particle irradiation; and injection of radionuclides from a nearby stellar source. Inheritance cannot explain the abundance of $^{60}$Fe, since our molecular cloud had to be isolated from Galactic nucleosynthesis sources for ~ 10$^8$ years to avoid over production of $^{129}$I; $^{60}$Fe is not inherited at all [3,4]. Irradiation fails to explain the meteoritic abundance of $^{60}$Fe by six orders of magnitude [5,6]. Injection from an asymptotic giant branch (AGB) star is extremely improbable, < 3 x 10$^{-6}$ [7], but a nearby supernova can account for the meteoritic $^{60}$Fe, and can reasonably account for most other radionuclides as well [8,9].

Time and Location of the Supernova: At the time of the supernova, the early Solar System was probably analogous to the protoplanetary disks seen in HST images < 1 pc from the massive (40 M$_\odot$) star $\theta$ Ori C (which will go supernova in ~1 Myr), in the Orion Nebula [10]. Most (50-90%) solar-mass stars form in such environments [11]. That protoplanetary disks, including our early Solar System’s disk, should be found near massive stars that will soon go supernova is easily understood as a natural consequence of star formation in such environments [12,13]. Injection after the protoplanetary disk has formed is therefore probably common, and is also consistent with the meteoritic evidence for “late injection” [14].

Disk Survival: We have conducted 2-D hydrodynamics simulations (to be presented) that show that a 0.013 M$_\odot$ disk, 55 AU in radius, located 0.3 pc from a supernova, will be stripped by its 2000 km/s ejecta to only 40 AU, but will survive the supernova. If the effective cross section of the disk for receiving supernova ejecta (with a 25 M$_\odot$ progenitor composition calculated by [15]) is $\pi(30 \text{ AU})^2$, then $^{60}$Fe/$^{56}$Fe = 5 x 10$^{-7}$ in the disk. That is, a protoplanetary disk 0.3 pc from a supernova can receive enough ejecta to explain the initial $^{60}$Fe in our Solar System, without being destroyed.