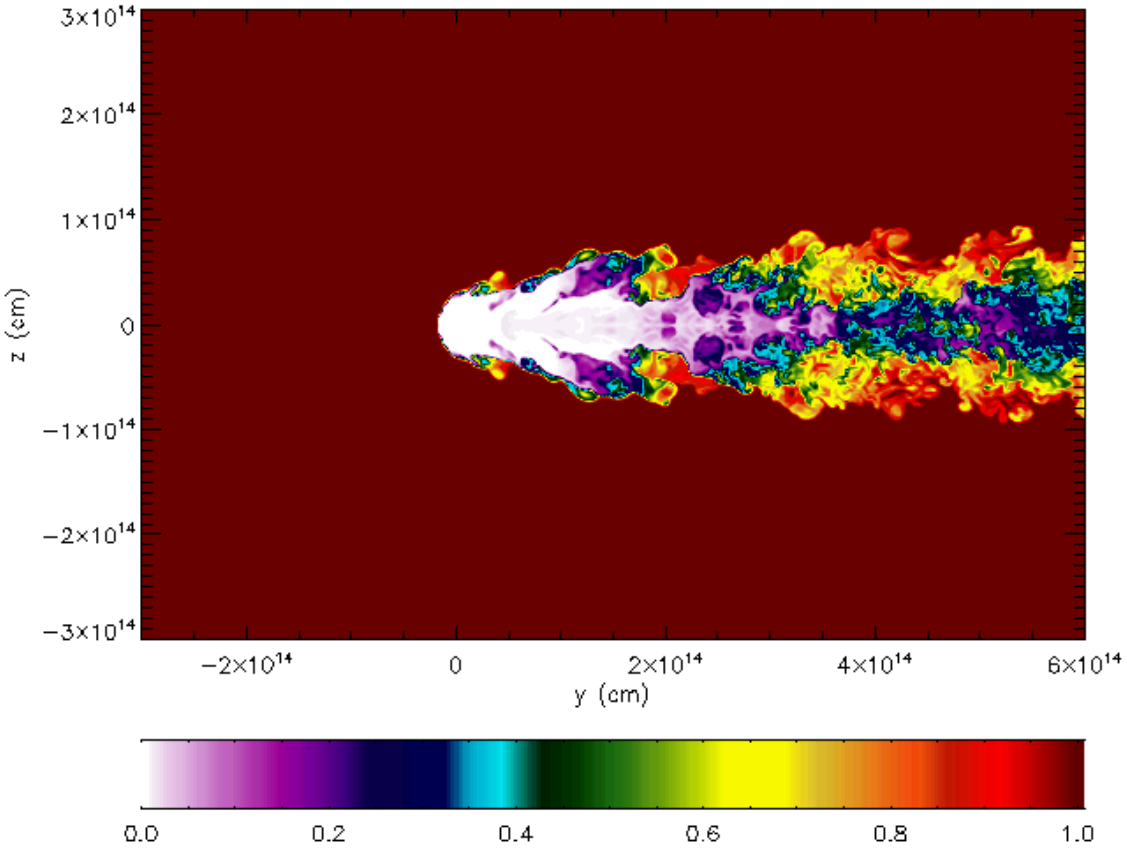
Injection of ^{60}Fe into the Solar System



Radioactive nuclei produced by astrophysical processes are a key for understanding the development of our Universe. The isotope ^{60}Fe plays a prominent role in a variety of different investigations, from new lifetime measurements and neutron capture cross sections to recent discoveries of live ^{60}Fe in the Milky Way, Earth's seafloor, and lunar regolith to extinct ^{60}Fe in meteoritic inclusions.

In this project we explore the injection of ^{60}Fe by a clump of ^{60}Fe enriched material from a core-collapse supernovae into the Solar System.

At least twice in its lifetime, our Solar System appears to have been affected by supernovae, with ramifications for life on Earth. At its birth, either before or during its protoplanetary disk stage, the Solar System acquired a suite of short-lived radionuclides. The origins of these radionuclides are probably only consistent with injection of ejecta from a core-collapse supernova a few light years away. Some 4.5 billion years later, distant supernovae could still touch Earth, as evidenced by the discovery of live ^{60}Fe in 3 million year old ferromanganese crusts from the Pacific Ocean seafloor, and preliminary findings of live ^{60}Fe in a lunar drill core. The amounts are consistent with a single supernova ~300 light years away. Injection of ^{60}Fe and ^{26}Al by a supernova during the Solar System's birth has major consequences for Earth's inventory of water and other volatiles. In exosolar planetary systems lacking ^{60}Fe and ^{26}Al, terrestrial planets can acquire masses of water exceeding 10-100 Earth oceans, an outcome that would obviously affect the development of life.

The figure represents the result of a collision between a supernova remnant and the solar wind. The supernova exploded 30 light-years away from our Solar System, and supernova material which include radioactivities such as ^{60}Fe and ^{26}Al can overcome the protective shield of the Solar Wind and enrich the Earth, Moon and other planets in these isotopes. The Sun is located at the center (0,0) and the supernova bullet enters the simulation box from the left. The box is of size 40 by 50 Astronomical Units, where an astronomical unit is the distance from the Sun to the Earth. For reference, the Solar System is about 100 AU across. Red represents supernova material, and the white represents solar wind material. The regions with other colors represent mixing between the supernova and solar wind material.

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