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Accounting for Short-Lived Radionuclides in the Early Solar System in the Context of a Triggered Star Formation Origin of the Solar System

A critical constraint on solar system formation is the high $^{26}Al/^{27}Al$ abundance ratio of 5×10^{-5} at the time of formation, which was about 17 times higher than the average Galactic ratio, while the $^{60}Fe/^{56}Fe$ value was lower than the Galactic value of 3×10^{-7}. This challenges the assumption that a nearby supernova was responsible for the injection of these short-lived radionuclides into the early solar system. We show that this conundrum can be resolved if the Solar System was formed by triggered star formation at the edge of a Wolf-Rayet (W-R) bubble. Aluminium-26 is produced during the evolution of the massive star, released in the wind during the W-R phase, and condenses into dust grains (that have been observed around W-R stars in IR observations). The dust grains survive passage through the reverse shock and the low density shocked wind, reach the dense shell swept-up by the bubble, detach from the decelerated wind and are injected into the shell. The dust grains will be destroyed by grain evaporation or non-thermal sputtering, releasing the ^{26}Al into the shell. Some portions of this shell subsequently collapses to form the dense cores that give rise to solar-type systems. The star will either collapse directly to a black hole, as in some models, or give rise to a supernova explosion. Even if the latter, the aspherical supernova does not inject appreciable amounts of ^{60}Fe into the proto-solar-system, thus accounting for the observed low abundance of ^{60}Fe. We discuss the details of various processes within the model, and conclude that it is a viable model that can explain the initial abundances of ^{26}Al and ^{60}Fe. Besides ^{26}Al and ^{60}Fe, many other short-lived radionuclides (SLRs) were present in the ESS, including ^{10}Be, ^{36}Cl, ^{41}Ca, ^{53}Mn, ^{107}Pd, ^{129}I, and ^{182}Hf. We further investigate whether the triggered star formation model can account for the abundance of these other SLRs, and show that it can adequately explain the abundances of most short-lived radionuclides in the early solar system.

Length of presentation requested

Oral presentation: 25 min + 5 min questions (Review-type talk)

Please select between one and three keywords related to your abstract

Origin of the Solar System

2nd keyword (optional)

Meteoritic Materials and Stardust

3rd keyword (optional)

Stellar evolution

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