GALACTIC CHEMICAL EVOLUTION, PRESOLAR GRAINS, AND THE SOLAR $^{18}$O/$^{17}$O RATIO. L. R. Nittler.
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Introduction: On the basis of radio measurements, it has been known for close to 30 years that the $^{18}$O/$^{17}$O ratio is some 25% lower in the interstellar medium (ISM) than in the Solar System [1, 2]. Recent infrared observations of protostars confirm this low ratio in the local ISM [3]. Models of Galactic Chemical Evolution (GCE) have predicted that $^{18}$O/$^{17}$O should remain constant as the Galaxy evolves [4], and this was supported by the original radio data, which showed no sign of a galactic radial gradient for this ratio [1]. A popular explanation for the discrepancy has long been local enrichment of the Sun’s progenitor cloud by one or more supernovae (SNe) [3, 4]. However, a number of theoretical and observational considerations indicate that local enrichment by SNe is not needed to explain solar $^{18}$O/$^{17}$O.

Galactic Chemical Evolution: A strictly constant $^{18}$O/$^{17}$O ratio during GCE is expected only if both isotopes are produced primarily in Type II SNe so that stellar evolutionary timescales are unimportant. The widely-used SN yields of [5] showed significant production of both isotopes, and GCE models based on these yields do indeed predict a flat $^{18}$O/$^{17}$O ratio in time and space [4]. However, more recent calculations [6], taking into account updated nuclear reaction rates, show that SNe cannot be the main source of $^{17}$O. Rather, this isotope is probably made primarily in classical novae and AGB stars. Because these sources have much longer evolutionary timescales than SNe, this implies that $^{17}$O production should come later than that of $^{18}$O and the $^{18}$O/$^{17}$O ratio should decrease with time, providing an alternative explanation for the discrepancy between the Sun and the present-day ISM. One study [7] took into account both novae and AGB stars in modeling the evolution of $^{18}$O and $^{17}$O, but did not discuss $^{19}$O. Thus, a quantitative model of O-isotope GCE taking into account current understanding of nucleosynthesis is still lacking. However, an apparent $^{18}$O/$^{17}$O gradient observed in the most recent radio survey [2] supports that this ratio changes with time. An alternative suggestion for the Sun’s $^{18}$O/$^{17}$O ratio is a presolar merger of the Milky Way with a dwarf galaxy [8].

Presolar Grains: A majority of presolar O-rich grains in meteorites are believed to have formed in low-mass AGB stars and their O isotopes reflect both GCE and internal nuclear processes in the parent stars [9]. The existence of many grains from long-lived (low-mass) stars with $^{18}$O/$^{17}$O ratios higher than the local ISM value as well as the results of simple Monte Carlo simulations [10] argue that the Solar $^{18}$O/$^{17}$O ratio was not atypical in the Galaxy for several Gyr prior to Solar formation.