**ORIGIN OF XENON ISOTOPIC COMPOSITION OF PHASE Q.**

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**Introduction:** Noble gases trapped in primitive meteorites are isotopically mass-dependant fractionated with respect to solar noble gases. They are quantitatively hosted by a poorly defined, organic phase [1], labeled phase Q. Xenon, which is the least prone to isotopic fractionation due to its lowest relative mass difference between isotopes, is enriched in heavy isotopes by +1.26±0.05 % per atomic mass unit in the carbonaceous chondrite Orgueil relative to Solar. In order to understand the origin of phase Q and its xenon isotopic composition, we have performed an experimental study coupled with theoretical calculation.

**Experimental method & theoretical calculation:** We performed adsorption experiments (< 1 eV) using Xe atoms and ions, ionized in a radiofrequency plasma. Within the reaction vessel, anthracite was heated in a furnace and the resulting organic particles were deposited onto the walls of the vessel, resulting in carbon-rich films. Xe was trapped either as ions in the ionization zone of the vessel, or as neutral atoms outside this zone.

Using the finite nucleus model [2], we determined the first ionization potential (FIP) by solving the relativistic Schrödinger-Dirac equation for each Xe isotopes for neutral atoms and for ions.

**Results:** Xe trapped from ionized Xe is tightly bound and is enriched by +1.36±0.06 %/amu (2σ) in heavy isotopes, reproducing the isotopic fractionation of Xe trapped in chondrites relative to Solar. Neutral Xe is more loosely trapped, is much lower in abundance, and is not isotopically fractionated. Ionized conditions allow the monotonic Xe isotopic composition observed in meteorites during stepwise heating release to be reproduced.

**Discussion:** Xe was not implanted into the film, because the energies of the incident Xe atoms and ions are far too low (< 1 eV). From the difference of behavior between ionic and neutral forms, we propose that Xe ions were trapped *via* chemical bonding at the surface of the newly created C-rich film. The observed mass-dependant fractionation of Xe is unlikely to have occurred in the gas phase as the difference in FIPs correspond to ≈ 1 $10^{-4}$ eV between $^{124}$Xe and $^{136}$Xe. As the mean experimental first ionization energy of xenon is 12.13 eV, the isotopic effect makes only ≈ 0.00008% difference in ionization energy between two Xe isotopes. Xe isotopic fractionation is more probably related to variations in chemical bonding strengths of Xe isotopes as chemical bonds involving heavy Xe isotopes are more stable than those involving light ones. The extent of fractionation could have been kinetically enhanced as a result of competition between film growth and Xe dissociation rate. The Q-noble gas fractionation and trapping characteristics are likely related to UV irradiation (from nearby young stars) of the surface of growing organic grains in the outer part of the solar system. For young stars, photons emitted in the far UV energy range (<100 nm) that are capable of ionizing noble gases were orders of magnitude more abundant than for the Present-day Sun, allowing efficient ionization of gaseous species

**References:** [1] Marrocchi *et al*. 2005 *Earth and Planetary Science Letters* 236:569-578. [2] Dyall K.G. *et al*. 1989 *Comp. Phys. Comm.* 55:425-446.