Recent and future developments of the RELAX mass spectrometer.

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RELAX (Refrigerator Enhanced Laser Analyser for Xenon) [1] combines a resonance ionization ion source, a cryogenic sample concentrator and a time-of-flight mass analyser to achieve ultrasensitive xenon isotopic analysis. The ionization process employs a two-photon excitation of the $5p^5$ 6p $[1/2]_0$ transition of the xenon atom followed by single-photon photoionization. Since this involves excitation of a j=0 state there is no mass independent fractionation. Gas is released from samples by laser step heating or laser probe into the instrument volume. With a duty cycle of 0.1 seconds sample gas is condensed onto a localised cold spot in the ion source and released by a heating laser pulse, increasing the concentration of xenon in the ionization region when the ionizing laser fires and so increasing sensitivity.

We have recently completed a series of upgrades to RELAX including installation in a temparature stabilised laboratory, commissioning of a new ionization laser, a new waveform digitiser for data acquisition with a 1 ns sampling rate and new data acquisition software. The lifetime against ionization of an atom in the instrument is now close to 120 seconds. Abundance ratios of the major atmospheric isotopes can be measured to 1% precision on samples of ~10^5 atoms of ^{132}Xe, while in a recent series of attempted analyses of individual presolar SiC grains the detection limit for ^{132}Xe was 1000 atoms (3 standard deviations of the blank). We have demonstrated our technique in a range of applications from presolar grain analyses and I-Xe dating of the early solar system to studies of the volatile reservoirs sampled by martian meteorites. Accompanying abstracts detail recent studies of the fission isotopes of Pu in Hadean zircons and the $\beta\beta$-decay of ^{130}Te in telluride ores.

In the near future we will upgrade our microchannel plate detector and increase the volume illuminated by our ionization laser, which will further improve sensitivity. In addition, we have begun development of a new version of RELAX that will allow simultaneous isotope- and element-ratio analysis of xenon and krypton. Krypton ionization will employ a doubly resonant process with excitation of the krypton atom at 116 and 558 nm before photoionization from the excited state at 1064nm[2]. Since these one-photon processes are inherently more efficient that the two-photon ionization of xenon, sensitivity in excess of that currently achieved for xenon can reasonably be expected.

[1] Gilmour J. D., Lyon I.C., Johnston W. A. and Turner G.. (1994) Rev Sci Inst **65**, 617.

[2] Thonnard N., Wright M. C., Davis W. A. and Willis R.D. (1992) in "RIS 1992", IoP Conf. Ser. No. 128, 27-30