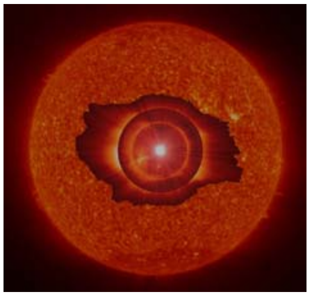
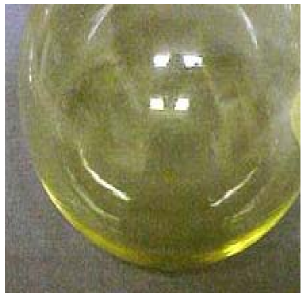
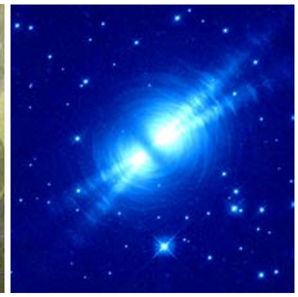
The Origin of Fluorine

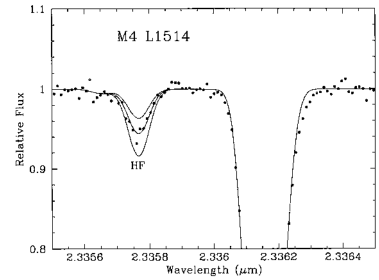




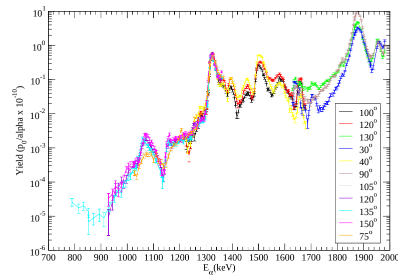


Fluorine is one of our best known elements. It is used in dentistry and house cleaning industry because it is chemically very active. Fluorine (^{19}F) is however also very reactive in stellar nuclear reactions, it is therefore depleted extremely rapidly at all stellar nucleosynthesis sites. The origin of fluorine has been unknown and speculations ran from AGB star inter-shell burning during late stellar evolution to neutrino induced production in supernova type-II explosions. Recent spectroscopic observations of post AGB stars showed strong indications of fluorine abundance in the stellar spectrum [1].

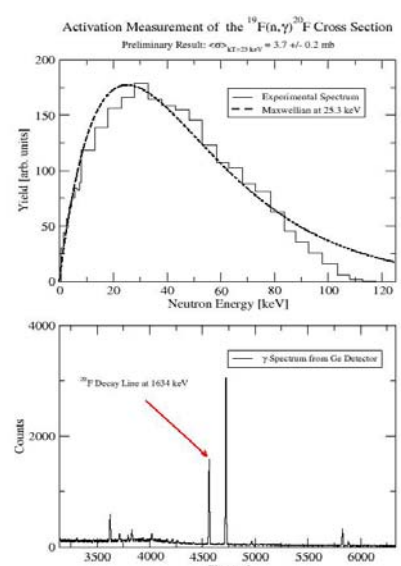
Recent experiments suggest that fluorine is produced in the hydrogen-helium burning shells during late stellar evolution of low mass stars by a sequence of hydrogen and helium capture reactions. The abundance of fluorine depends critically on the various depletion processes at the nucleosynthesis site [2]. Accelerator studies of nuclear reactions on fluorine have been performed at the Notre Dame nuclear laboratory to simulate the stellar burning conditions. In particular the most important depletion reaction $^{19}F(\alpha,p)$ has been measured over a wide energy range. The excitation curve for the ground state transition is shown at the right hand panel. R-matrix simulations have been performed to extrapolate the experimental data into the stellar energy range [3]. This measurement was complemented by the study of the neutron capture reaction $^{19}F(n,\gamma)$, which is the second most important depletion process for fluorine. This experiment was performed at the Forschungszentrum Karlsruhe, Germany. A Maxwell Boltzmann shaped neutron spectrum corresponding to the stellar temperature at the AGB star site was produced using the $^{7}Li(p,n)$ reaction. The neutron capture cross section was measured by monitoring the characteristic γ activity of teyh 20F reaction products. The cross section was significantly smaller than previously predicted [4]. Extensive computer simulations of stellar nucleosynthesis based on these new data show that the observed fluorine is produced in 3-4 solar



^{19}F observation in stellar spectra of hot post-AGB stars as L1514.



Experimental excitation curve and R-matrix analysis of $^{19}F(\alpha,p_0)^{22}Ne$ measured at different angles



Experimental data and R-matrix analysis of $^{19}F(\alpha,p_1)^{22}Ne$ measured at different angles.

mass stars independent of the initial metallicity Z. This work is still in preparation.

Publications:

[1] K. Werner, T. Rauch, and J. W. Kruk, A&A 433 (2005) 642

[2] Maria Lugaro , Claudio Ugalde , Amanda I. Karakas, Joachim Görres, Michael Wiescher, John C. Lattanzio , Robert C. Cannon, Astrophys. J. 615 (2004), 934

[3] C. Ugalde, R.N. Azuma, A. Couture, J. Görres, H. Lee, E. Stech, W. Tan, and M. Wiescher, Phys. Rev. C (2007) submitted

[4] E. Uberseder, M. Heil, F. Käppeler, J. Görres, M. Wiescher, Phys. Rev. C (2007) in print

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