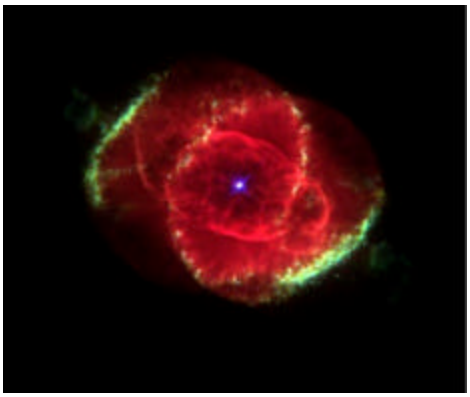
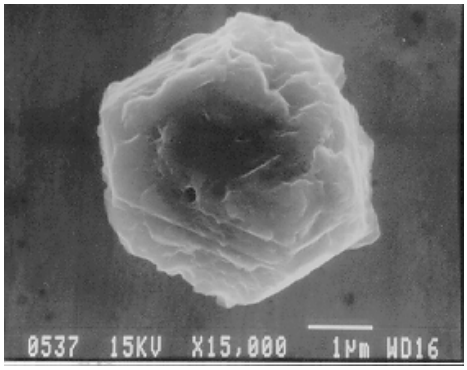
Red Giant Stardust From the *s* process

The need for new, high-precision neutron measurements is being driven by new observations and new, more realistic models.



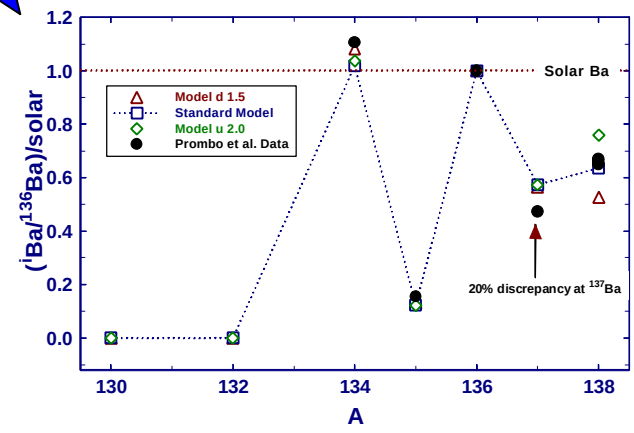
Planetary nebula from the death of a red giant star.



SiC stardust from meteorite

Most isotopic anomalies found in meteoric grains appear to be due to the *s* process in red giant stars. New instruments being installed expected to increase sensitivity by factor of 10.

Barium isotopic anomalies

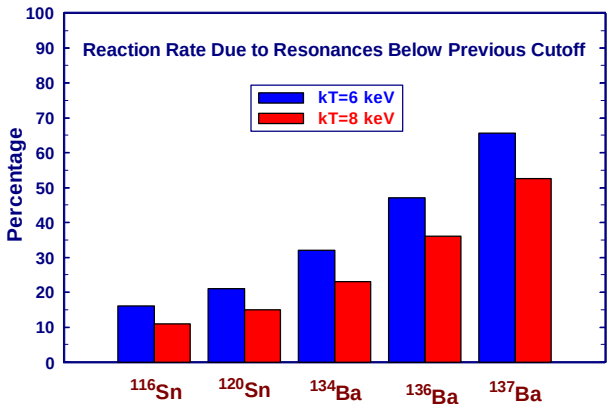


Recent precise ORELA data are making meaningful test of this red giant stardust model possible.
More (*n*,?) data needed for other elements observed in stardust (Sr, Mo, Dy,…).

The Cool New *s*-process Stellar Models

New stellar *s*-process models indicate that most of the neutron exposure occurs at much lower temperatures than previously thought (*kT*=6-8 keV vs. 30 keV).

Most previous measurements as well as many recent measurements from other facilities don't go to low enough energies; hence, currently rely on extrapolated rates. ORELA is ideally suited for measuring rates across entire range needed.

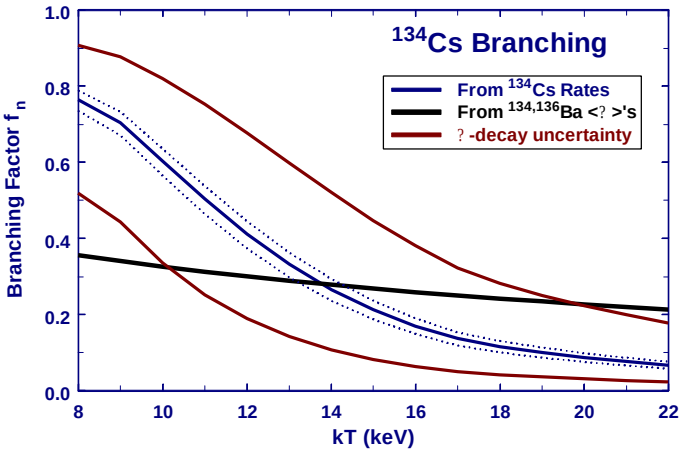


New ORELA data show that 10-70% of reaction rate missed by previous measurements and that uncertainties underestimated by factors of 2-3.
Important to measure for *s*-only isotopes (^{116}Sn, ^{122,123,124}Te,…).

Example of Astrophysics Impact: ORELA ^{134,136}Ba(*n*,?) data.

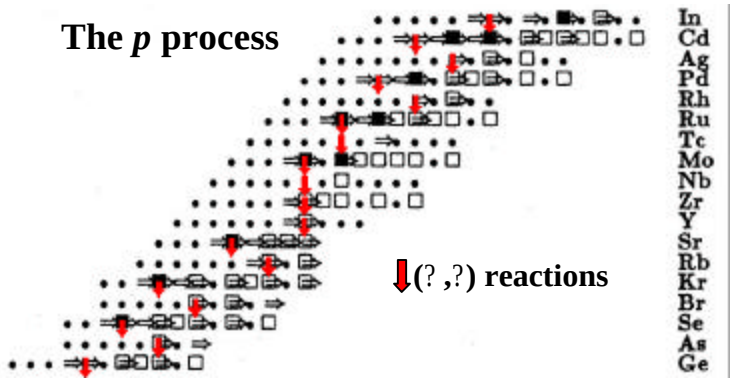
First evidence of temperature variation during the *s* process.

Predicted by dynamical stellar models, but never "observed".



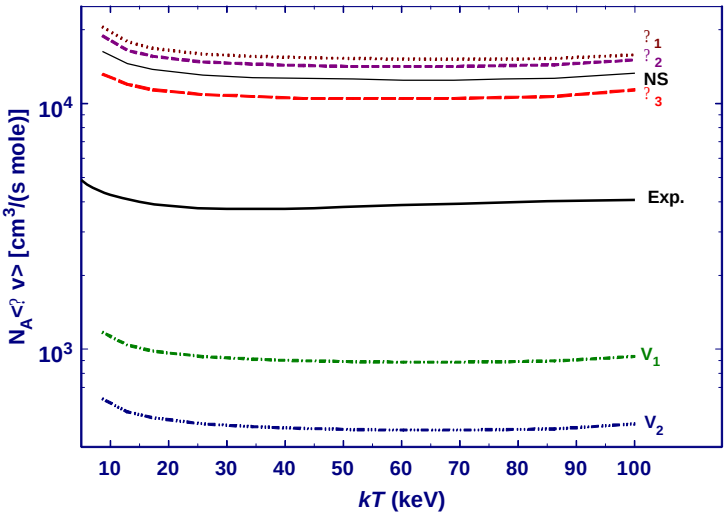
Improving Reaction Rates for Explosive Nucleosynthesis Studies

- Rates for ? -particle reactions important for nucleosynthesis in massive stars and supernovae, but very uncertain.
- The largest nuclear physics uncertainty for the *p* process.
- Difficult or impossible to directly measure.



- Statistical model should work, but ? -potential poorly known.
- (*n*,?) measurements best means for constraining ? -potential.
- New detector developed at ORELA makes measurements possible at astrophysical energies for the first time.
- First results show needed sensitivity to ? -potential and that best nuclear models off by factors of 3-4.
- More measurements across global mass range needed and possible.

^{147}Sm(*n*,?) Reaction Rate from ORELA



Theory, with different level densities.

ORELA Experiment.

Theory, with different ? potentials.