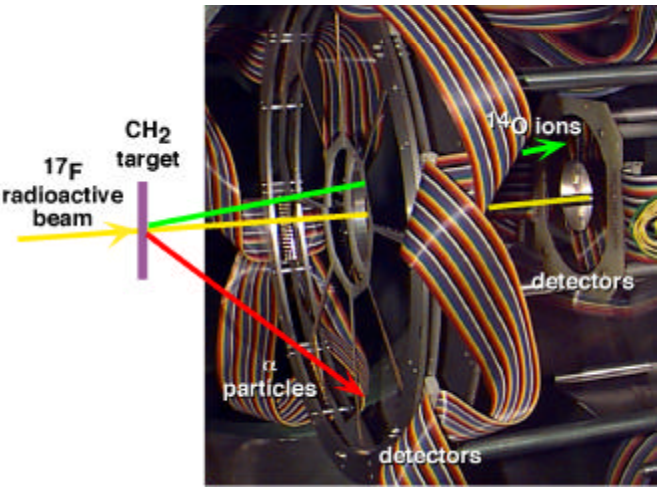
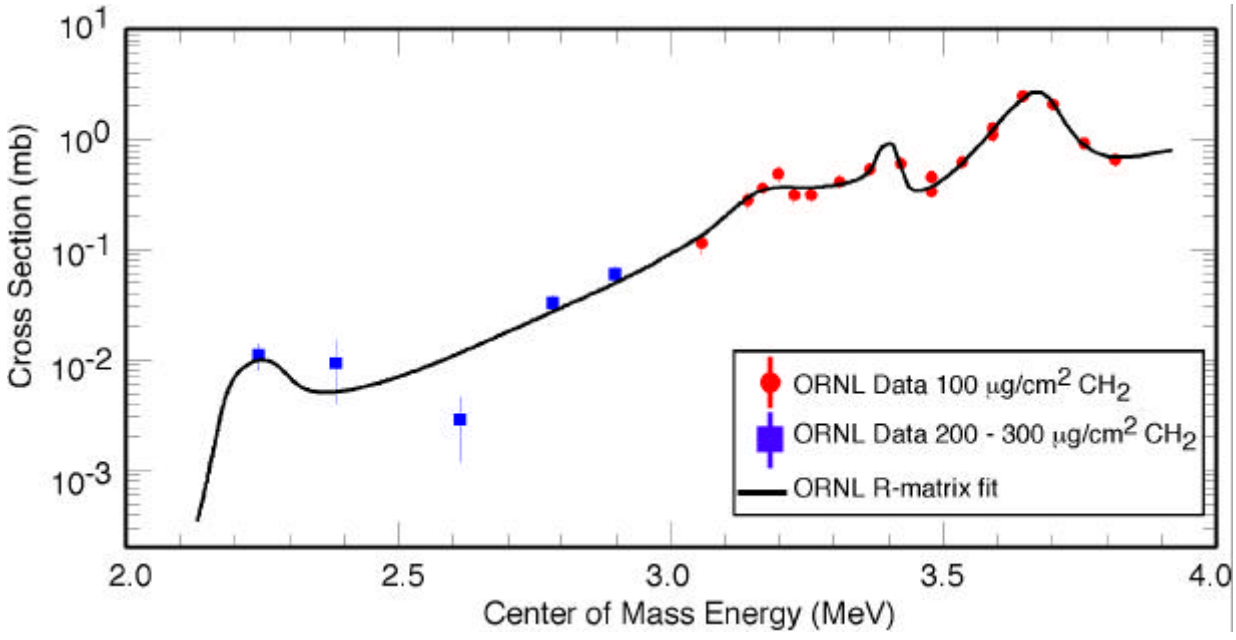
Study of the $^{14}O(?,p)^{17}F$ Reaction in Stellar Explosions with an HRIBF Radioactive Beam

Artist's Conception of an X-ray Burst

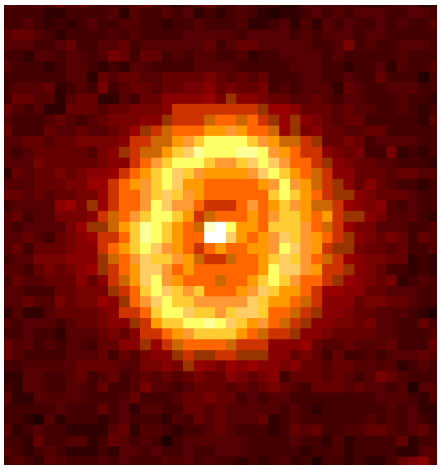


Experimental Setup for the $^{17}F(p,?)^{14}O$ Measurement at HRIBF

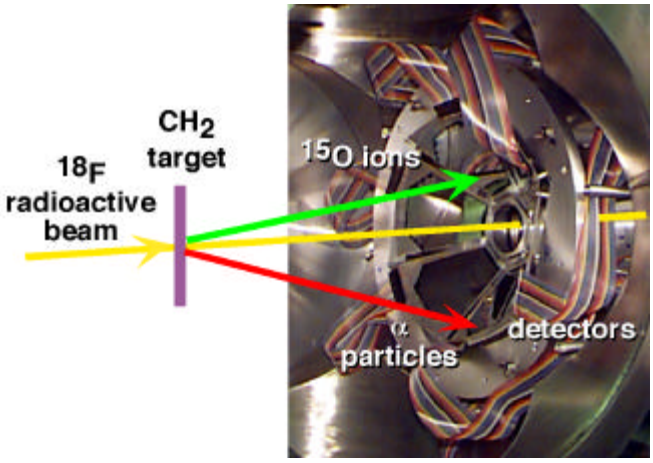
- $^{14}O(?,p)^{17}F$ reaction **triggers X-ray Bursts** and is important in the synthesis of elements in Nova Explosions
- Need to measure the reaction yield as a function of energy
- A ^{17}F radioactive beam and a CH_2 target were used to measure the **inverse** $^{17}F(p,?)^{14}O$ reaction at ORNL's HRIBF
- Measured cross section at 21 energies with beam intensities up to 10^6 particles / s covering the entire range of interest for astrophysics
- **Gives first firm experimental basis** for $^{14}O(?,p)^{17}F$ reaction rate in stellar explosions (ground state transitions only)
- Results differ from previous predictions
- Future studies planned to determine contribution of ^{17}F excited states



Study of the $^{18}F(p,\gamma)^{15}O$ & $^{18}F(p,\gamma)^{19}Ne$ Reactions in Stellar Explosions with HRIBF Radioactive Beams



Hubble Space Telescope Image Of Exploding Star Nova V1974
[Univ. Wyoming & Space Telescope Science Institute]



Experimental Setup for the $^{18}F(p,\gamma)^{15}O$ Measurement at HRIBF

Uncertainty in ^{18}F + p reactions gives factor of ~300 uncertainty in ^{18}F production in nova explosions

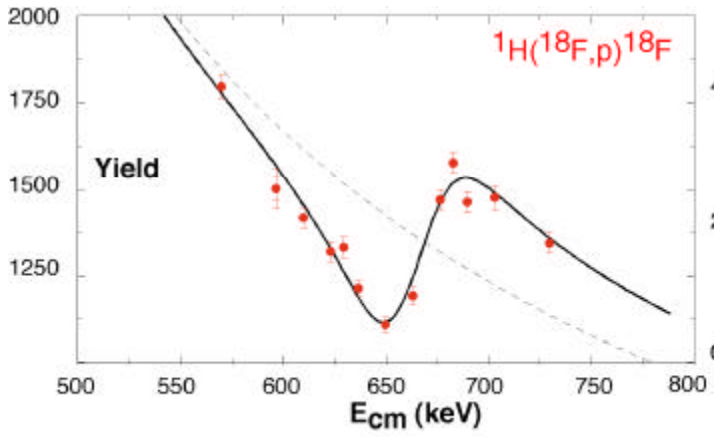
This uncertainty makes it impossible to determine the required sensitivity of γ-ray satellites searching for this long-lived radioactive isotope in explosion ashes

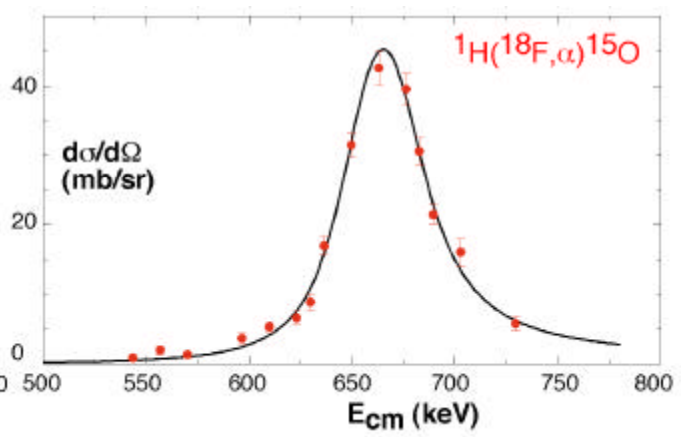
Previous measurements have serious discrepancies

A ^{18}F radioactive beam and a CH_2 target were used to measure $^{18}F(p,\gamma)^{15}O$ & $^{18}F(p,p)^{18}F$ at ORNL's HRIBF

Precision parameters** determined for a ^{19}Ne resonance dominating the ^{18}F + p reactions; **discrepancies resolved

Future studies planned to search for missing ^{18}F + p resonances in ^{19}Ne





Astrophysical Implication of $^{17}F(p,p)^{17}F$ Measurement at HRIBF

Experimental Goal: *Search for Missing ^{17}F + p Resonance in ^{18}Ne*

9 unsuccessful experimental searches with stable beams

New HRIBF Measurement with a ^{17}F radioactive beam in 1999 –

first unambiguous evidence for resonance

precise determination of resonance perties

APS Dissertation Award 2001 - Dan Bardayan

Astrophysical Implications

change ^{17}F + p fusion rate by up to factor of 100 in novae

change predictions of synthesis of some isotopes such as ^{17}O

by up to a factor of 5