CEX and the City

Charge-Exchange Experiments
using (t,3He) at the NSCL

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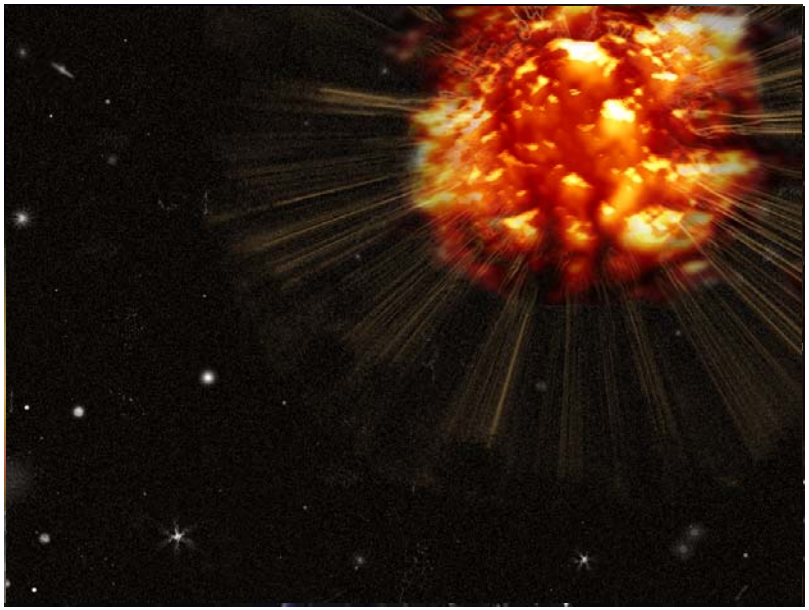
The following graduate school preview has been approved for the Physics Grad audience.

Rated PG The following talk contains unnecessary double entendres and implicit sexual references that may offend tender ears. Student supervision is advised.

CEX and the City

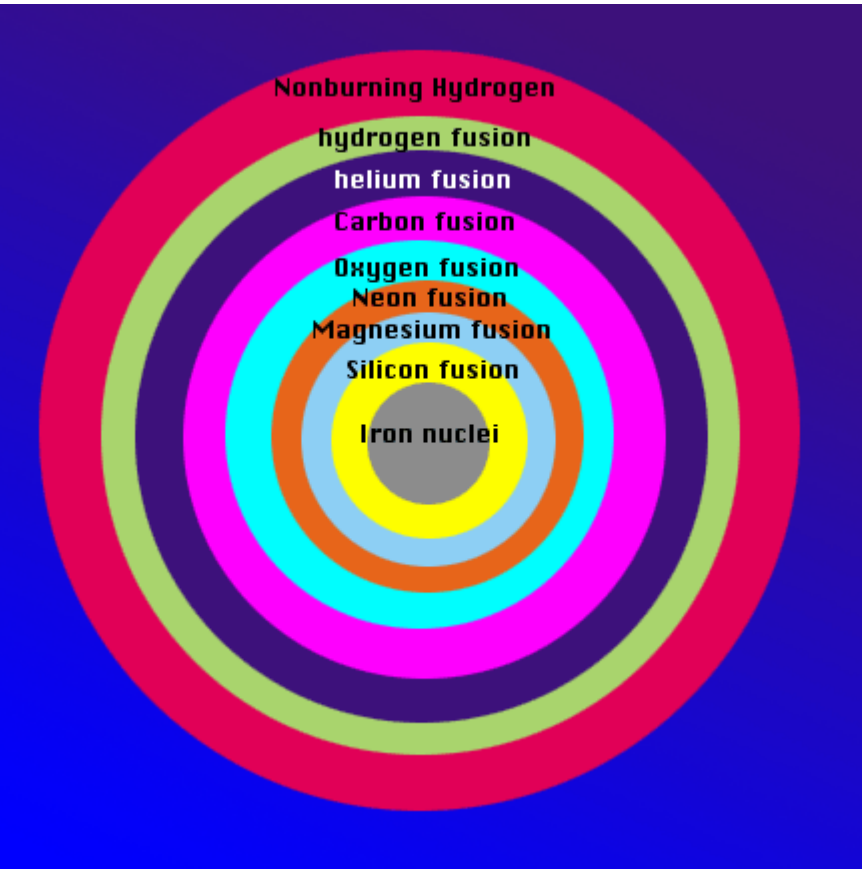
Outline



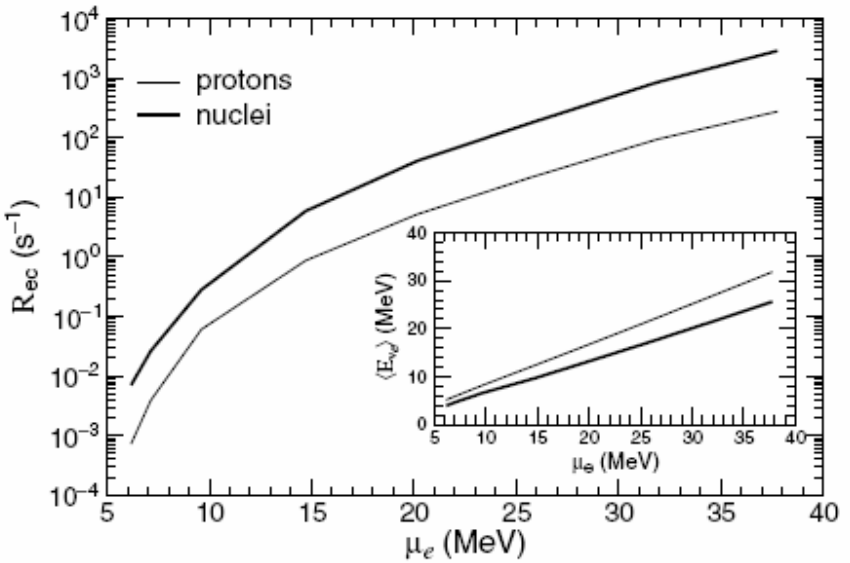
Supernovae

- Motivating Gamow-Teller strengths B(GT) from charge-exchange
- (t,^{3}He): Experimental considerations for Charge-Exchange at the NSCL
- A recent experiment

Relevance in Astrophysics



Reaction Rates for Electron Capture



Langanke et al. PRL 90 241102 (2000)

EC now considered important for SN Ia A=55-65 and SNII A≤112

Gamow-Teller Strengths: Modeling SNe

Weak Interactions

- Important in shock wave propagation?
- Cooling through sweating neutrinos?
- Reduce densities in core?

e- Capture Rates

- Complex relationship with pressure, Y_e, entropy, SN dynamics, deleptonization.
- Late stage burning$\rightarrow Y_e$ $Y_e^2 \rightarrow$Chandrasekhar limit

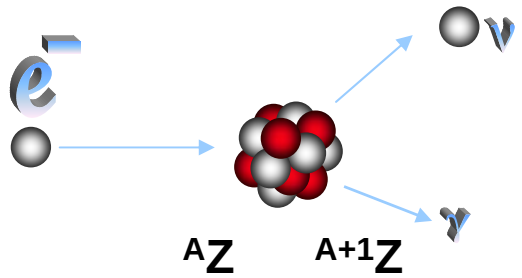
Sensitivity

- Content and extent of nuclear networks changes output of SN models

The Birds and the B(GT)s

$$B(GT_+) = \sum_{i,f} \frac{n_i^p n_f^h}{(2j_i+1)(2j_f+1)} \left| \langle f | \vec{\sigma}\tau_+ | i \rangle \right|^2$$

$$\frac{d\sigma}{d\Omega}(q=0) = \left[\frac{\mu}{2\pi\hbar}\right]^2 \frac{k_f}{k_i} N_D |V_{\sigma\tau}|^2 \left| \left\langle f \left| \sum_k \sigma_k \tau_k \right| i \right\rangle \right|^2$$



$$\frac{d\sigma}{d\Omega}(q=0) = KN_D \left| J_{\sigma\tau} \right|^2 B(GT)$$

Resources for B(GT)s

- β decay data: only g.s. to low E_x, limited nuclei!
- CEX measurements
- Calculations remainder of input in reaction networks

Mass	*B(GT) from Theory*	*Mass*	*SN Phase*
14-40	full SM (*sd*-shell)	<65	Pre-Collapse
40-80	large scale SM	>65	Peri-, Post-Collapse
>80	upper lim. B(GT)		

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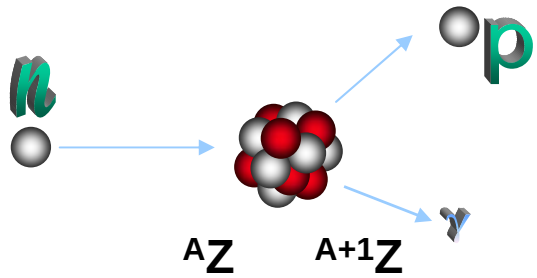

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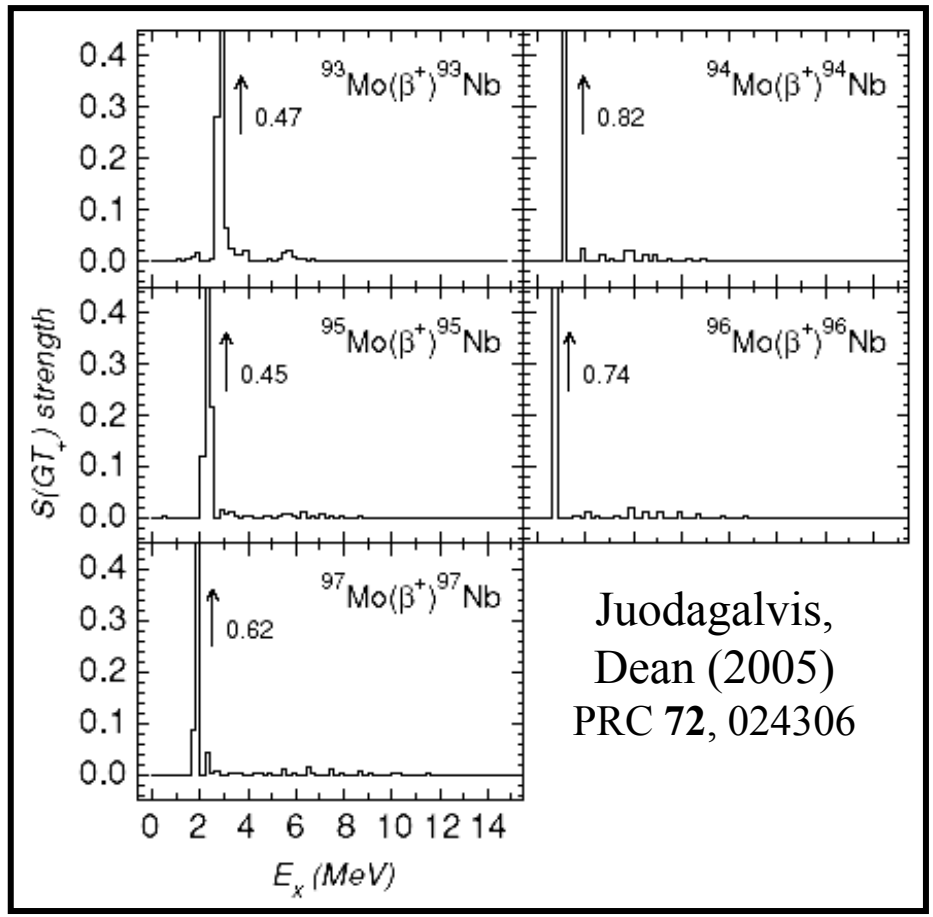
Picking Your Battles: ^{63}Cu, ^{94}Mo

63Cu Not included in previous SN reaction networks. Relevant in *pre-collapse* type II and type Ia SNe.

94Mo Higher mass important in *post-(core-)collapse* SNe. Tests calculations with different large model spaces. (Some calculations overpredict strengths.)



Juodagalvis, Dean (2005) PRC **72**, 024306

Triton Production at NSCL

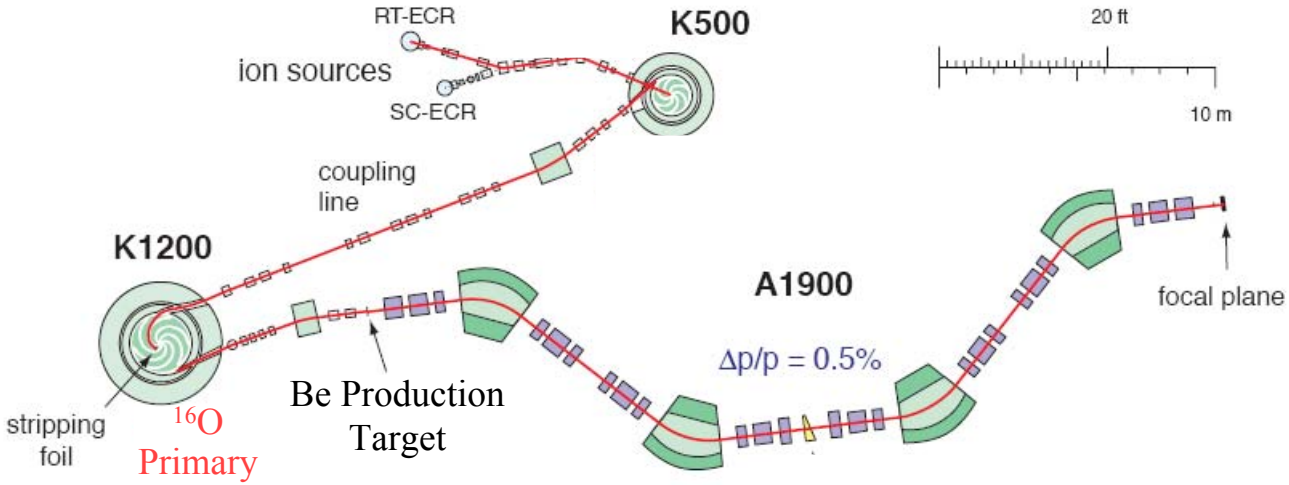
Primary Beam:
^{16}O 150 MeV/A

↓

^{9}Be Production Target

↓

Select ^{3}H (Z/A)



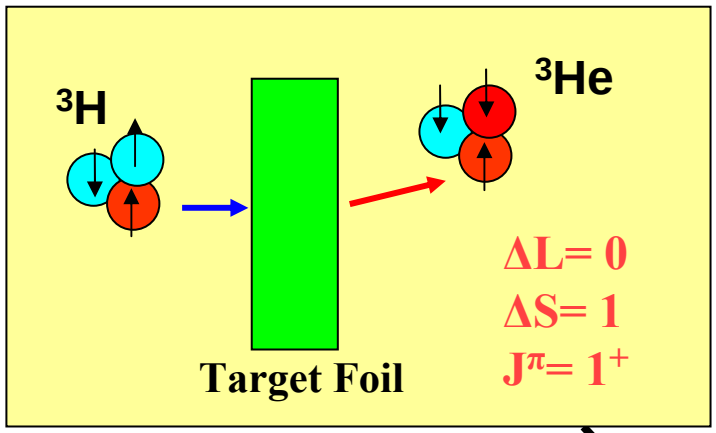
A1900 Fragment Separator

New Triton Rate: ~10^{7} pps (2004)

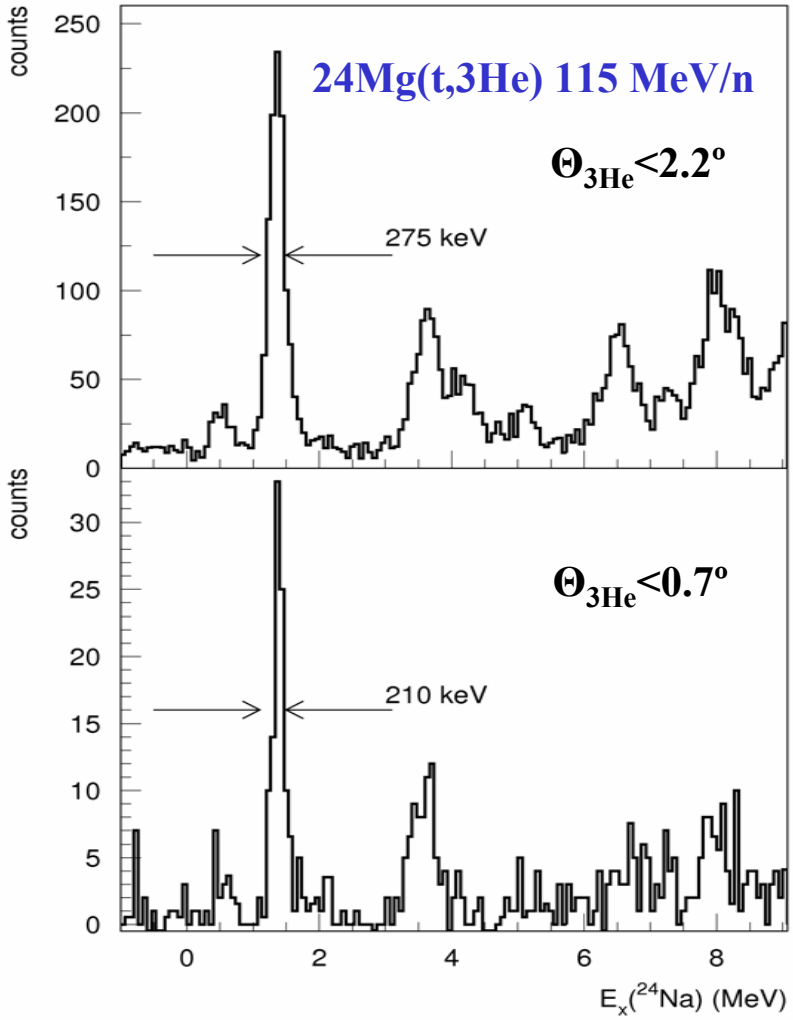
x 5-10 Improvement on primary alpha beam rate

Transmission rate to experiment improved ~25% (2005)
Paper in progress (W. Hitt et al.)

Experimental Setup



Current (t,^{3}He) Experiment



TARGETS

^{12}C: calibrate beam intensity
→ norm. σ

^{24}Mg: normalize B(GT)

^{63}Cu: First measurement

^{94}Mo: First measurement

E resolution ~ 200 keV

Now in analysis.

Collaborators

Ed Smith, Diane Reitzner

Remco Zegers, Arthur Cole, Wes Hitt, D. Bazin, S. Austin, M. Famiano, A. Gade, D. Galaviz, W. Martinez, M. Matos, H. Schatz, B. Sherrill, Y. Shimbara, C. Simenel, A. Stolz

TRIUMF: B. Davids

Saha INP: C. Samanta

Next Episode of *CEX and the City*…

More (t,3He)

Experiment schedule for Fall 2005: 2 new targets

(*Thesis: G.W. Hitt*)

B(GT) and systematic study of (t,3He) probe

New Probes

- Inverse kinematics
- Unstable nuclei

  At RIA?
- Approved experiment for (7Li,7Be*) in inverse kinematics at NSCL