Neutron Transfer Effects in Nuclear Fusion

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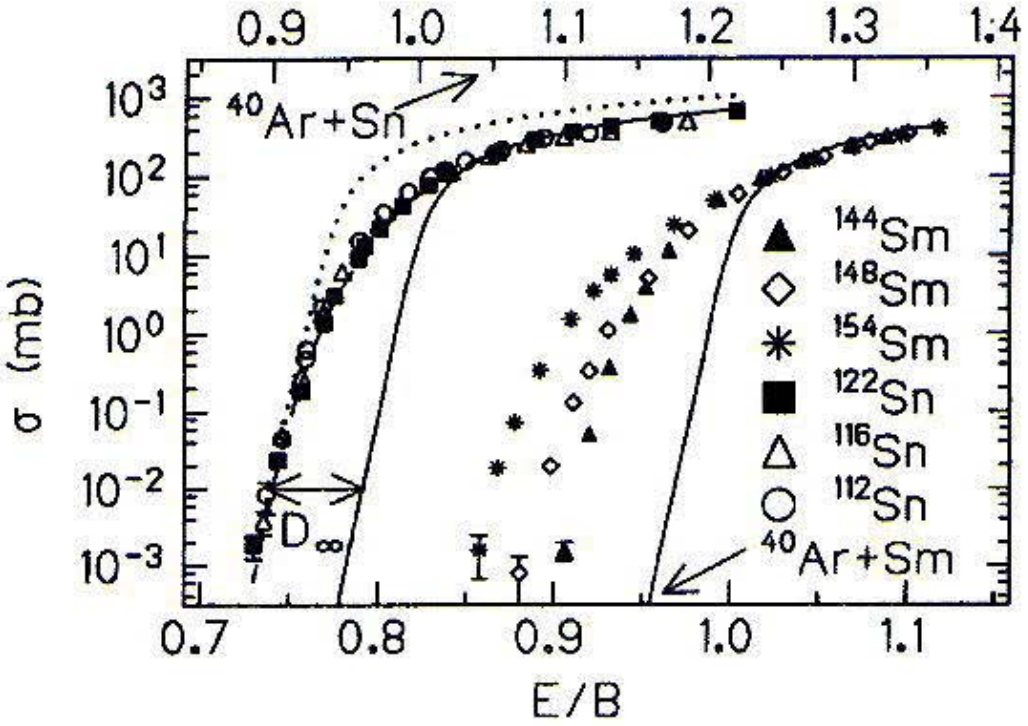
Fusion Enhancement



W. Reisdorf, J. Phys. G, 20 (1994) 1297-1353

- one-dimensional calculations do not reproduce the measured cross sections
- nuclei with strong rotational and vibrational states show larger fusion enhancement
- strong isotopic dependence

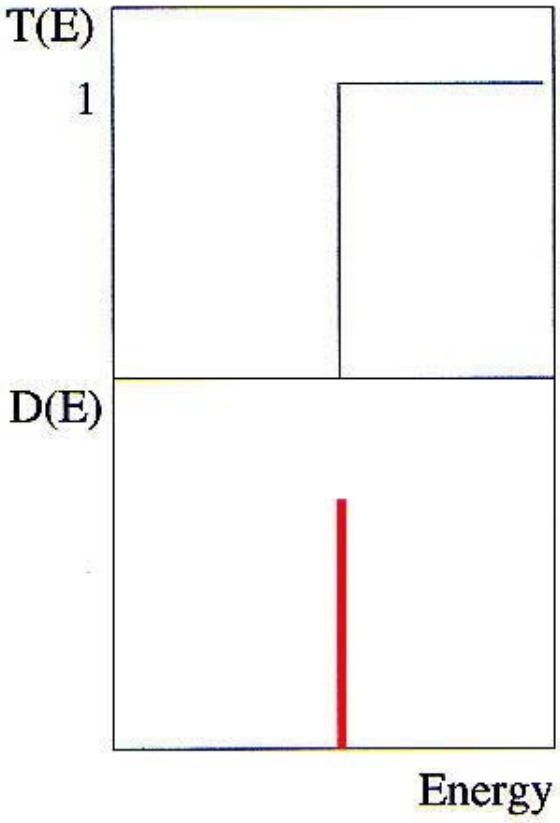
fusion is a multi-dimensional problem

other degrees of freedom couple to the relative motion

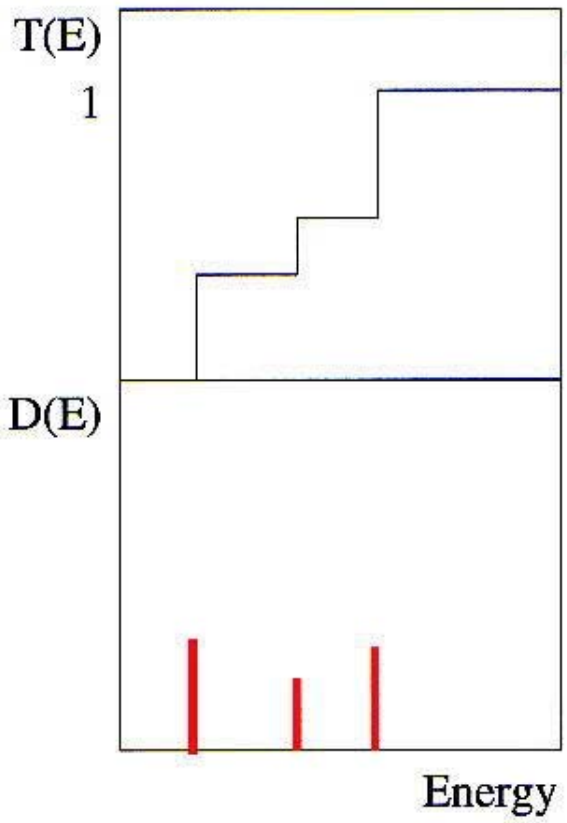
The Distribution of Barriers

$$\sigma^{fus}(E) = \int D(B)\,\sigma(B,E)\,dB$$

Single Barrier Case



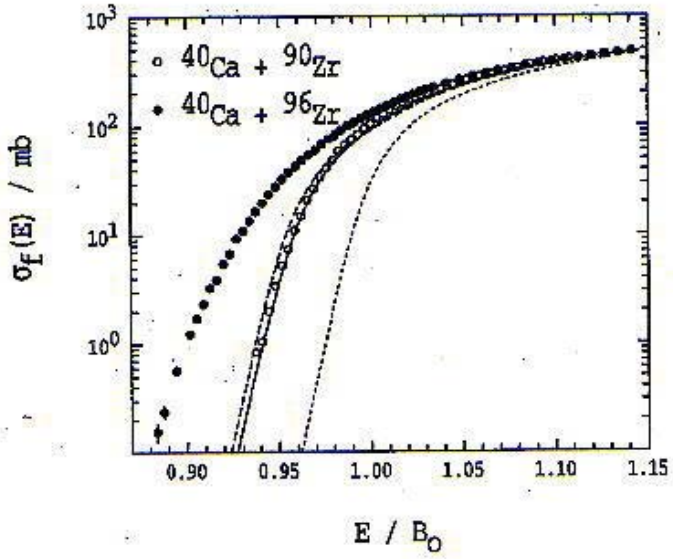
Multiple Barriers



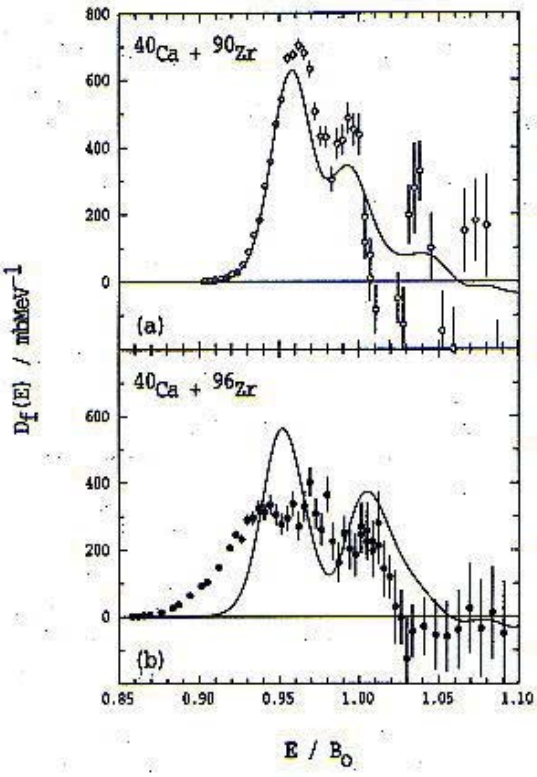
$$D^{fus}(E) \equiv \frac{dT}{dE} = \frac{1}{(\pi R_0^2)} \frac{d^2}{dE^2}\left(E\,\sigma^{fus}(E)\right)$$

$$\frac{dT}{dE} = \frac{d}{dE}(1-R) = \frac{-dR}{dE} \equiv -D^{qel}(E)$$

The Influence of Neutron Transfer



H. Timmers et al., Phys Lett B, 399 (1997) 35-39



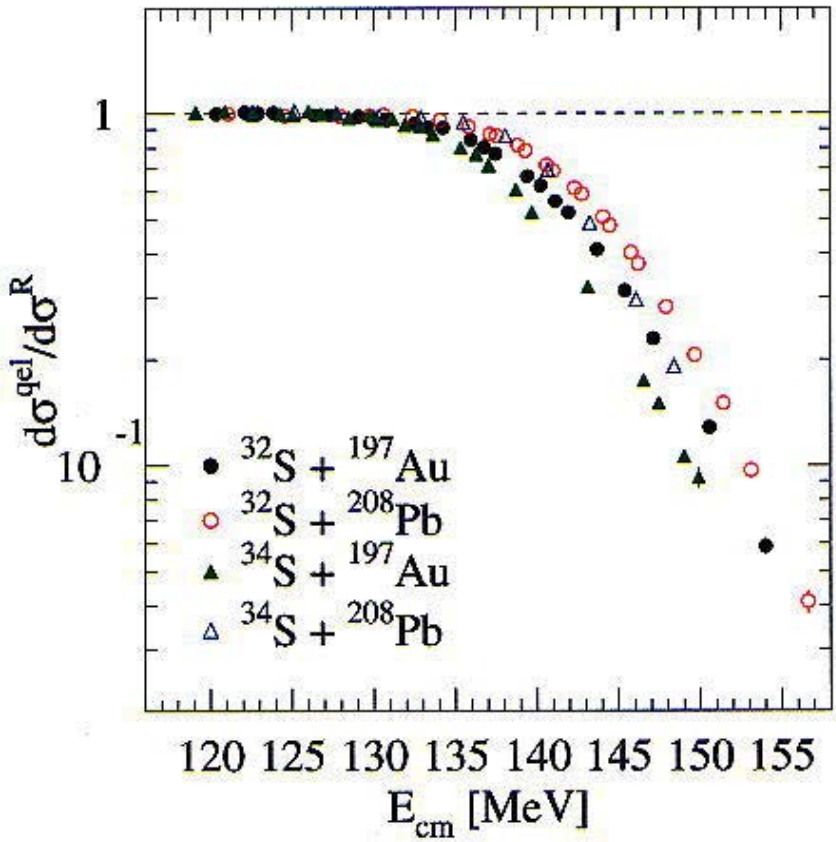
Q-values for neutron transfer for ^{40}Ca+ ^{90,96}Zr [MeV]:

	1n	2n	3n
$^{40}Ca + ^{90}Zr$	-3.611	-1.445	-5.861
$^{40}Ca + ^{96}Zr$	0.509	5.525	5.239

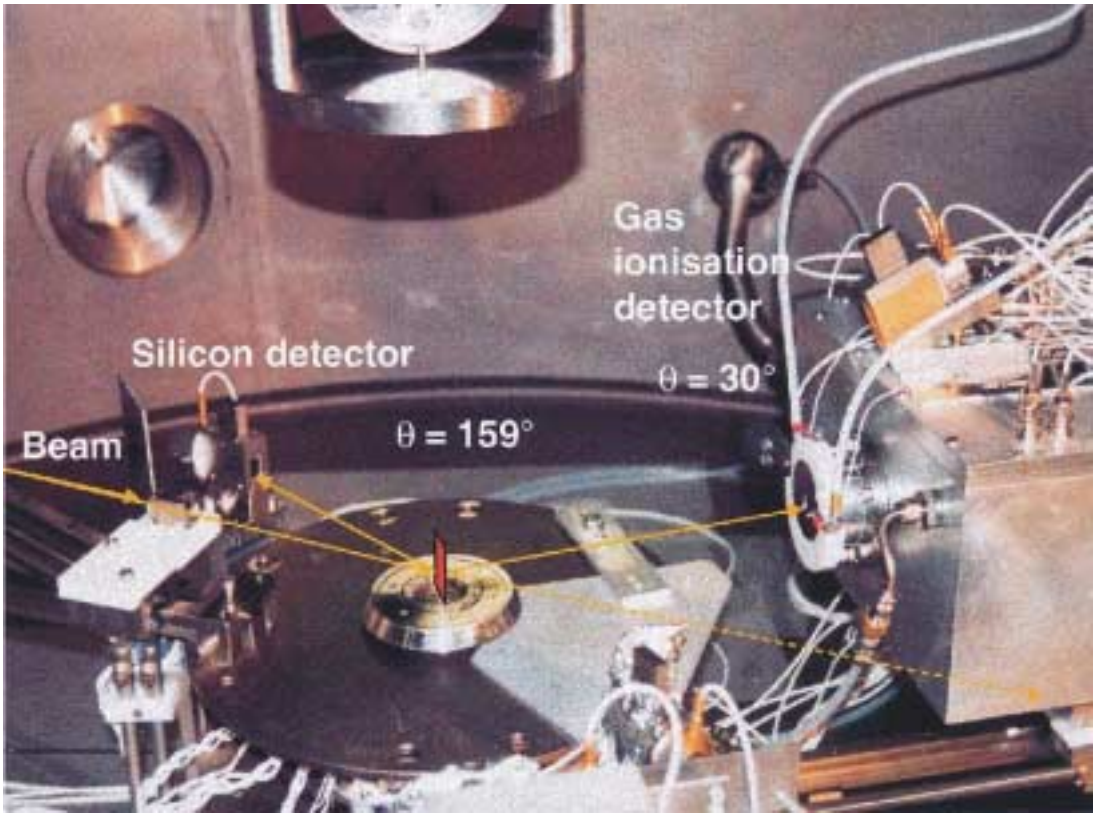
$^{32,34}S + ^{197}Au, ^{208}Pb$

Q-values for neutron transfer [MeV]:

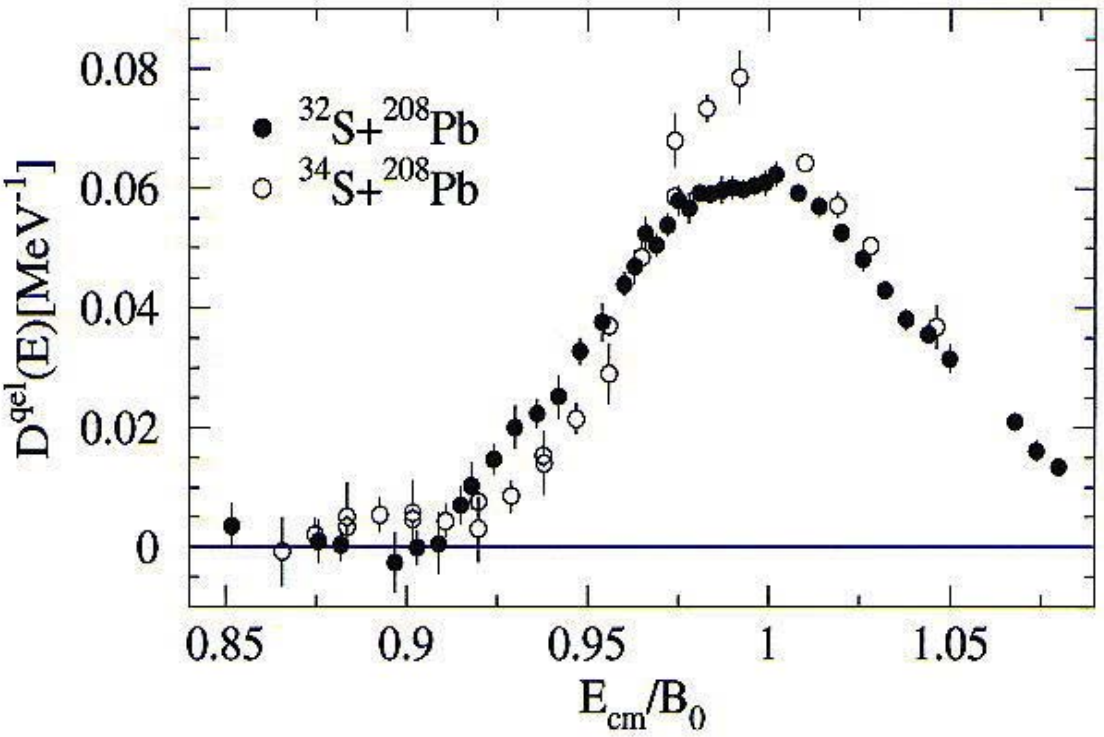
	1n	2n		1n	2n
$^{32}S + ^{197}Au$	0.569	5.342	$^{32}S + ^{208}Pb$	1.274	5.953
$^{34}S + ^{197}Au$	-1.086	2.158	$^{34}S + ^{208}Pb$	-0.382	2.769
$^{36}S + ^{197}Au$	-3.768	-2.377	$^{36}S + ^{208}Pb$	-3.064	-1.766

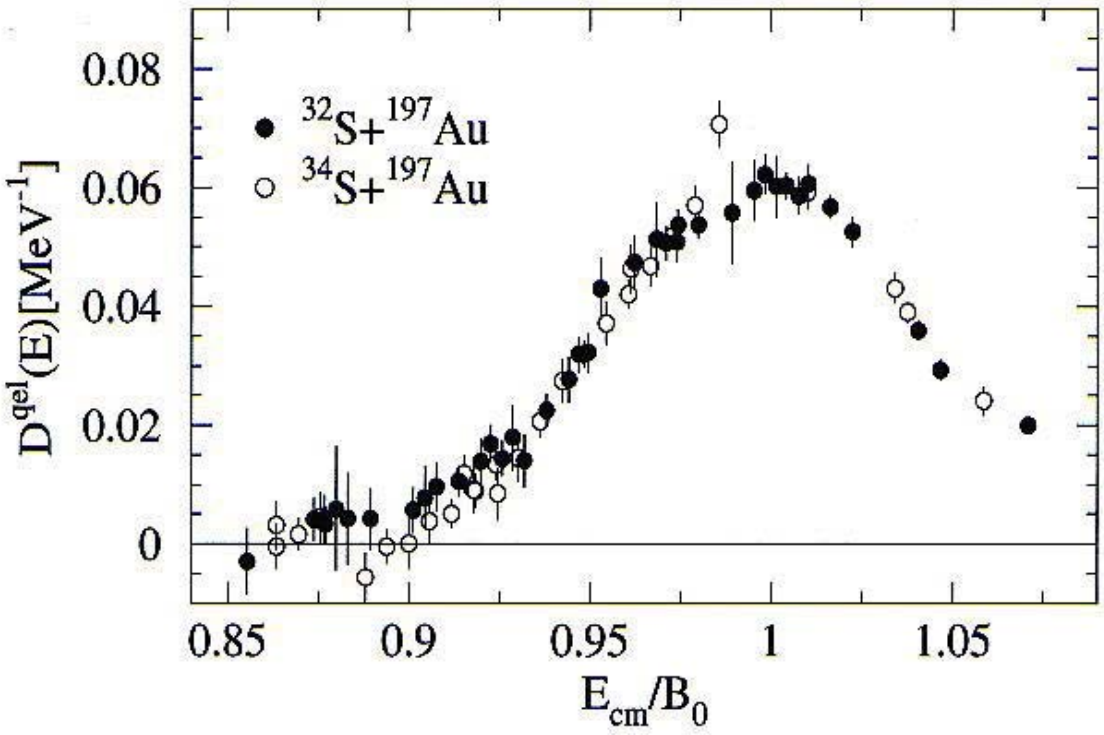


Experimental Setup



$^{32,34}S + ^{197}Au, ^{208}Pb$





Exploiting Barrier Distributions

- phenomenological approach to fusion
- measurements of fusion and/or quasi-elastic scattering excitation functions
- systematic investigation of isotopic variations
- additional test of theory
- extension to heavy systems

Heavy Systems

- average barriers shift to higher energies
- large number of available reaction channels
- weakly coupling channels become more important
- importance of transfer channels increases with system size
- transfer of many particles as link between simple reactions and neck formation