Low-lying Structure of ^{132,134}Xe from Inelastic Neutron Scattering

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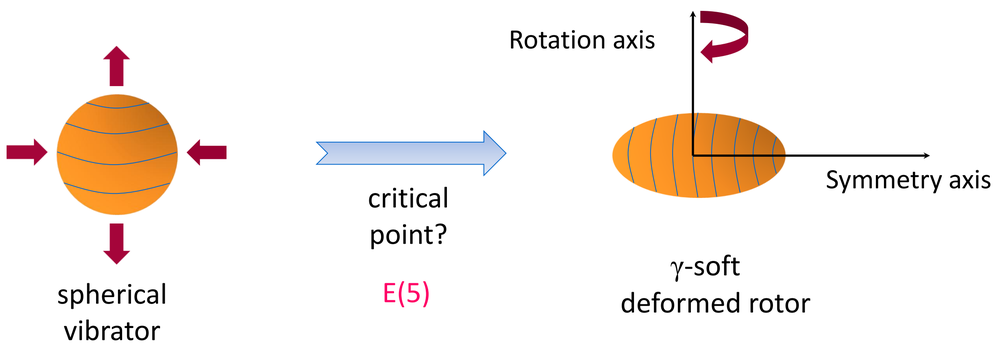
Why Xe?

Iachello* proposed that a critical point exists for the transition of a spherical nucleus to a deformed rotor.

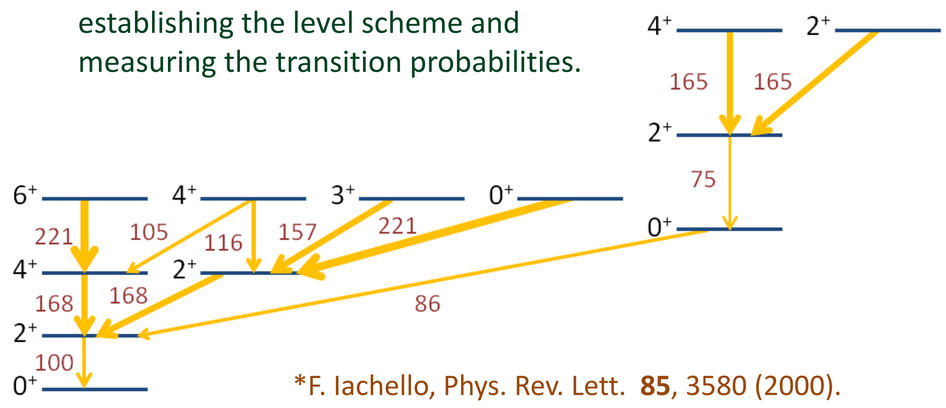
Do the stable isotopes of xenon exhibit this transition?



E(5)? Xe

136, 134, 132, 131, 130, 129, 128, 126, 124

An E(5) nucleus can be identified by establishing the level scheme and measuring the transition probabilities.



*F. Iachello, Phys. Rev. Lett. **85**, 3580 (2000).

Experiments at the University of Kentucky Accelerator Laboratory: Inelastic Neutron Scattering and DSAM Lifetimes

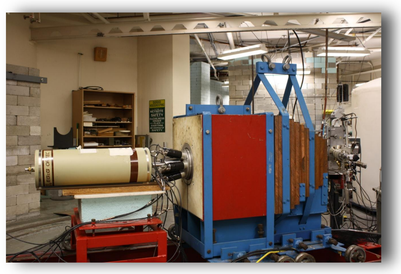
UK 7-MV Van de Graaff Accelerator

The accelerator with the tank removed

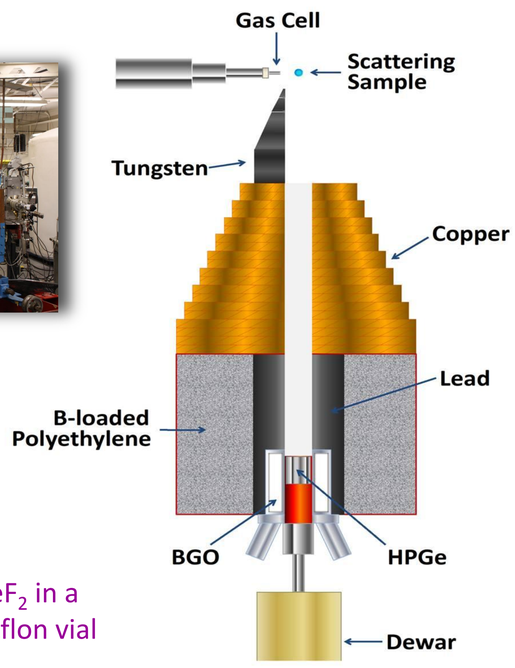
H^+ ions are created by ionizing hydrogen gas.

Excitation functions
- Vary neutron energy
- Detection angle constant at 90°
- Construct level scheme

Angular distributions
- Constant neutron energy
- Detection angle varied from 40°-150°
- Transition multipolarities, level lifetimes, multipole mixing ratios, and transition probabilities



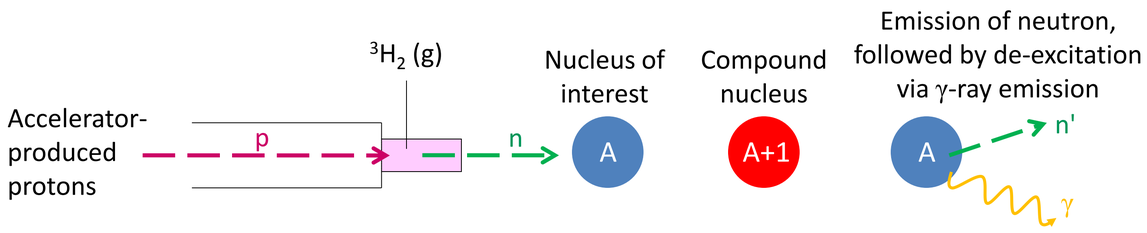
Experimental setup



Enriched XeF_2 samples!
~10 g of each isotope enriched to > 99.9%

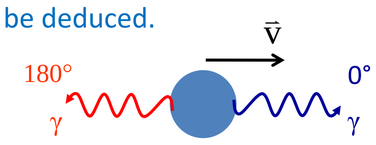
XeF_2 in a Teflon vial

Nearly monoenergetic neutrons are produced by the $^3H(p,n)^3He$ reaction and inelastically scatter from the nucleus of interest.

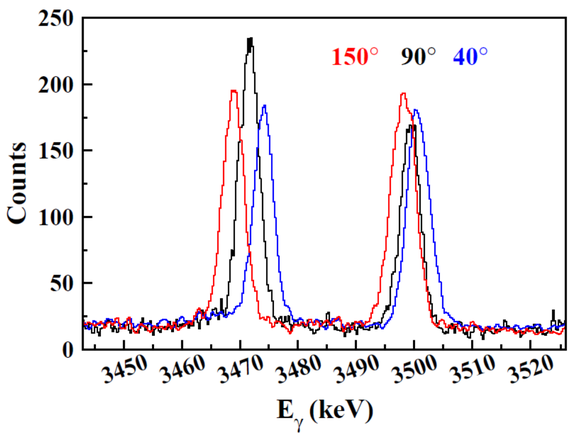


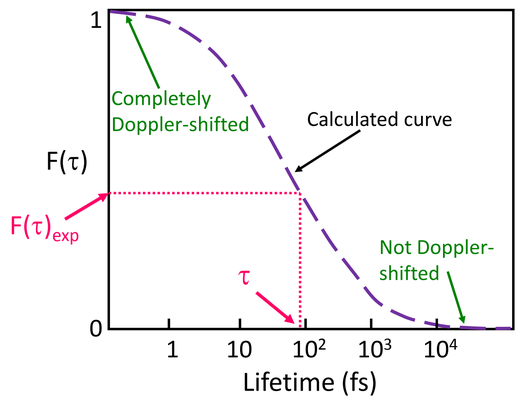
Lifetime measurements via the Doppler-shift attenuation method (DSAM)

If the γ ray is emitted while the nucleus is recoiling, it experiences a Doppler shift. By measuring the γ-ray energy as a function of angle, lifetimes in the femtosecond regime can be deduced.



$$E_\gamma(\theta) = E_\gamma\left[1 + F_{exp}(\tau)\frac{v}{c}\cos\theta\right]$$

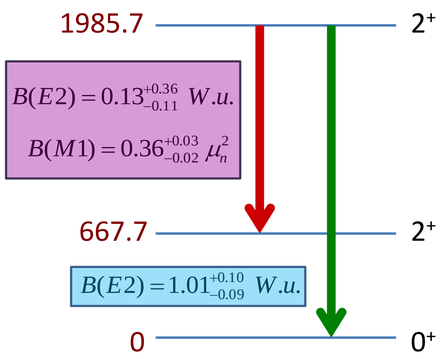




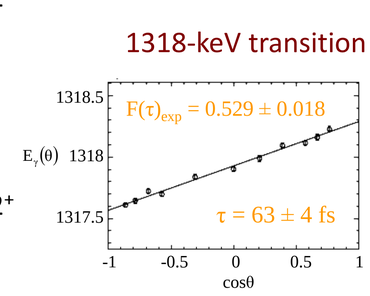
T. Belgya, G. Molnár, and S.W. Yates, Nucl. Phys. A607, 43 (1996).

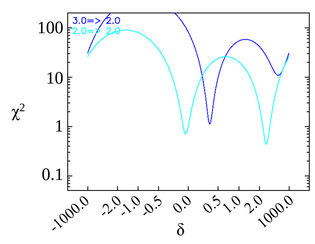
Nearly Final Results

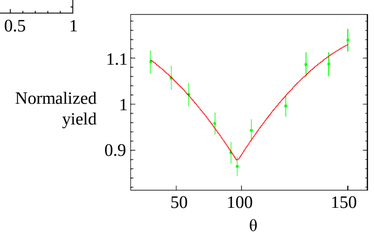
^{132}Xe



1318-keV transition

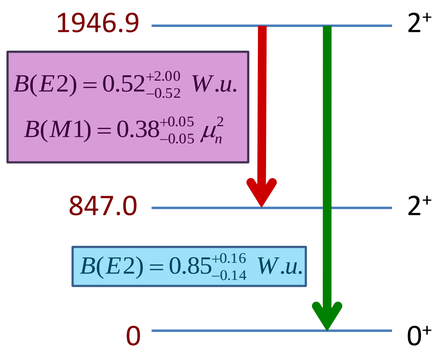




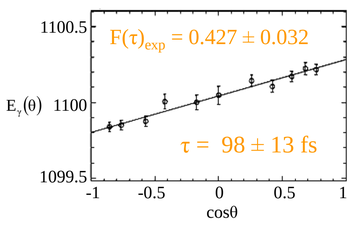


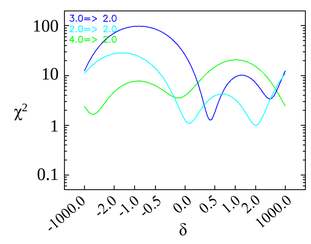
Mixed-symmetry state candidate
L. Coquard, *et al.* Phys. Rev. C **82**, 024317 (2010).

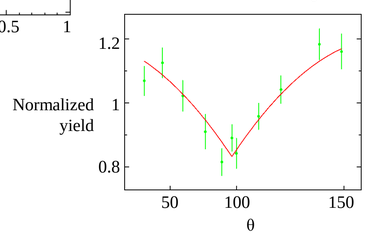
^{134}Xe



1100-keV transition

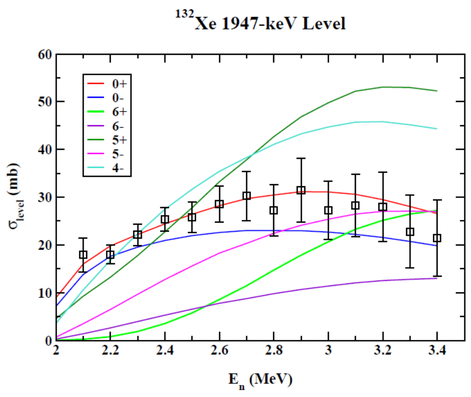




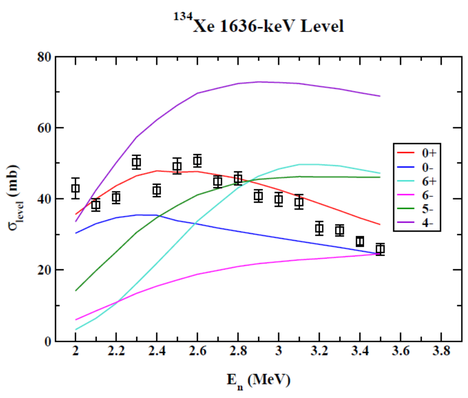


Mixed-symmetry state candidate
T. Ahn, *et al.* Phys. Lett. B **609**, 19 (2009); **682**, 490 (2010).

Comparison of experimental cross section with statistical model (CINDY) calculations reveals the new 1947-keV level as a candidate for a 0^+ state.



E(5)? — While some transition probabilities have been determined and candidates for excited 0^+ states identified, further experiments and data analysis must be completed in order to characterize the structures of ^{132}Xe and ^{134}Xe and to determine whether either can be described as an E(5) nucleus.



Comparison of experimental cross section with statistical model (CINDY) calculations supports the assignment of the 1636-keV level as a 0^+ state.

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