



# Statistical properties of $^{133}\text{Xe}$ and the $^{132}\text{Xe}(n,\gamma)$ cross section

H. C. Berg  
bergh@frib.msu.edu

10th Workshop on Nuclear Level Density and Gamma Strength  
19.05.2026



UNIVERSITY  
OF OSLO



MICHIGAN STATE  
UNIVERSITY

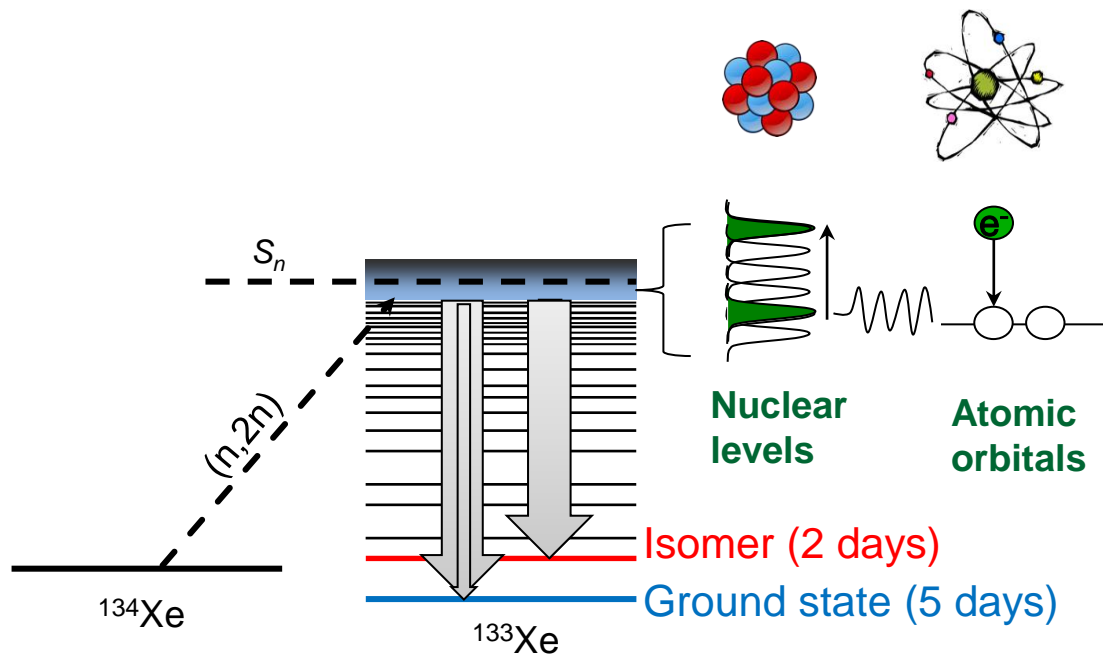


U.S. DEPARTMENT  
of ENERGY | Office of  
Science



This material is based upon work supported by the Department of Energy National Nuclear Security Administration through the Nuclear Science and Security Consortium under Award Number(s) DE-NA0003180 and/or E-NA0000979.

# Why $^{133}\text{Xe}$ - Nuclear Plasma Interactions

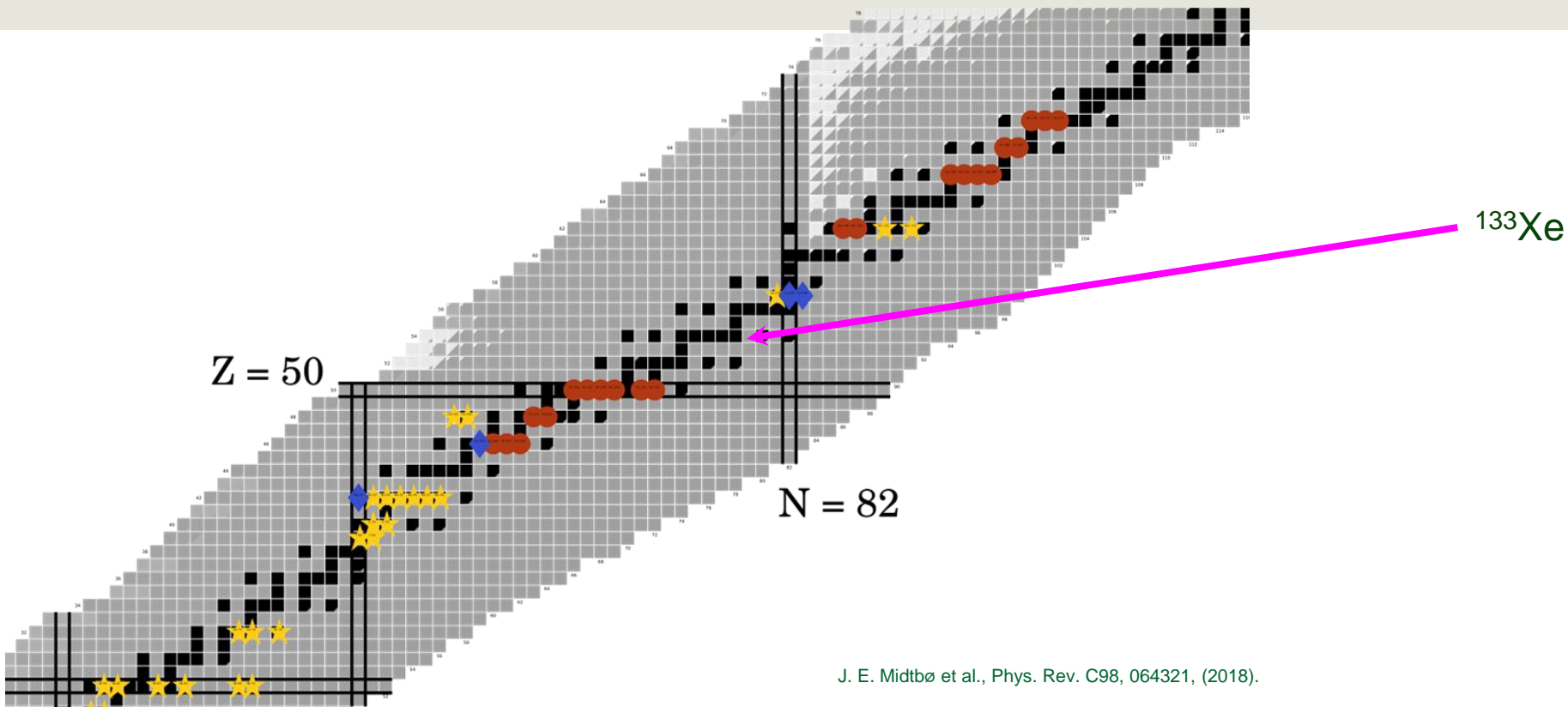


Nuclear Excitation by  
Electron Capture  
(NEEC)

Measuring the isomer  
to ground state ratio

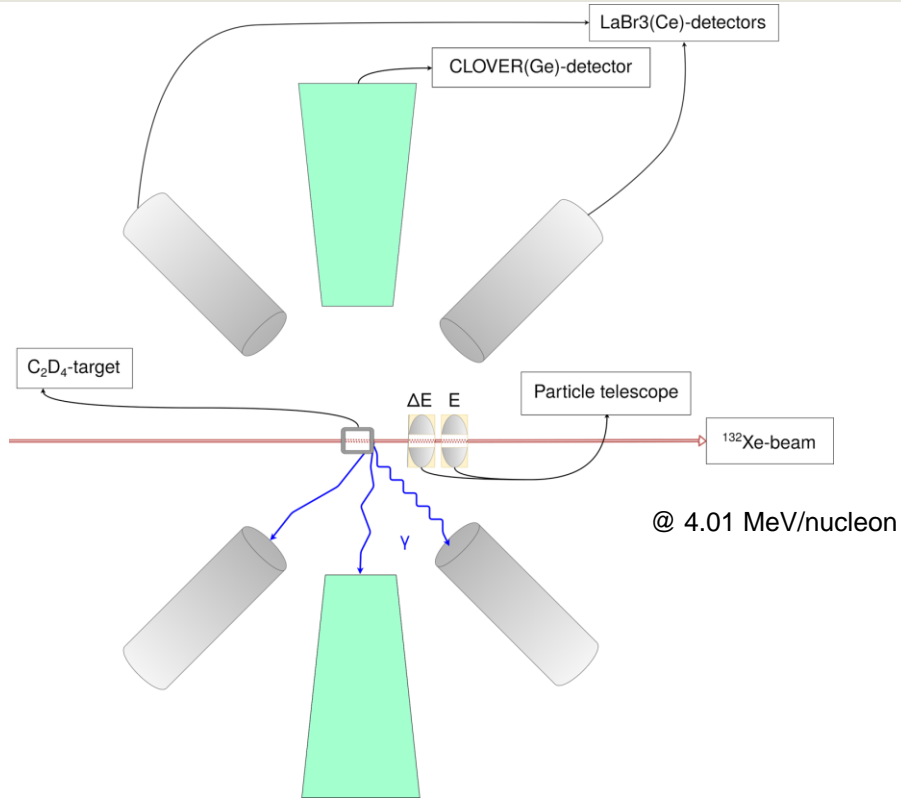
Animation: D. L. Bleuel, private communication (2019).

# Low energy enhancement

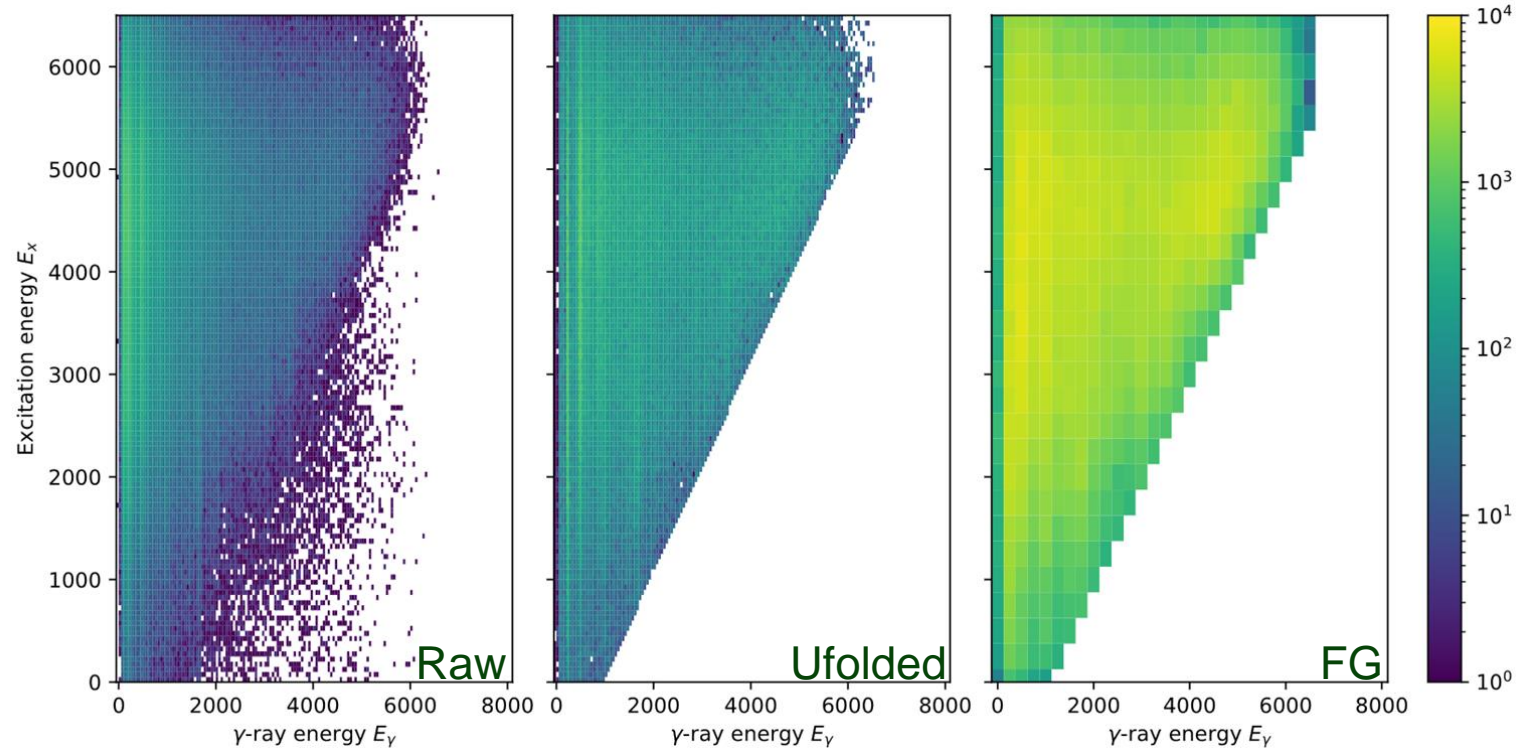


J. E. Midtbø et al., Phys. Rev. C98, 064321, (2018).

# Experiment



# Oslo method

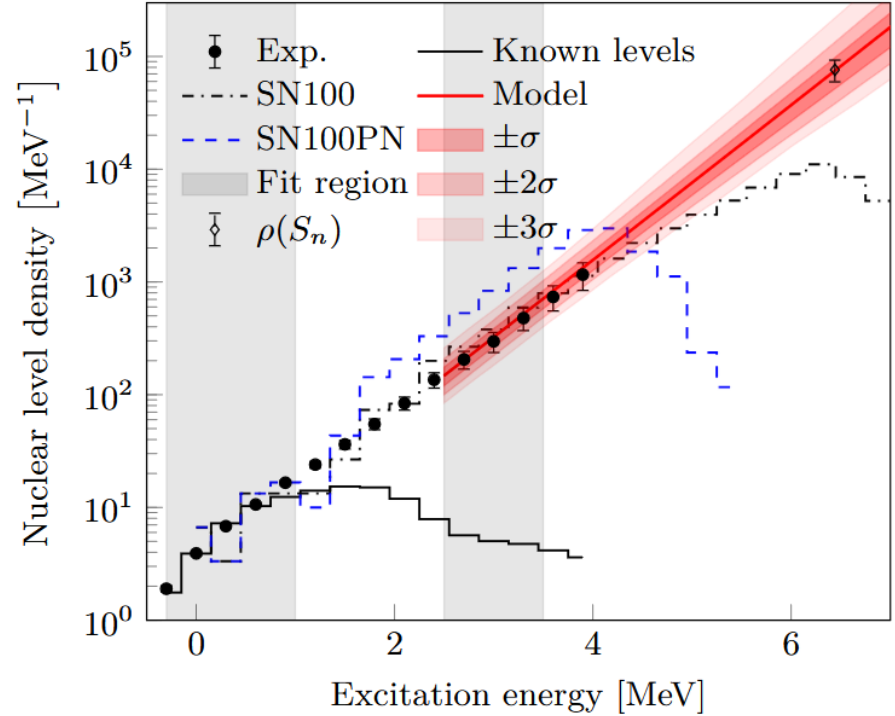


# Normalization

- Likelihood function to find parameters for normalization simultaneously

$$\mathcal{L}(\{\rho_i\}, \{f_i\} | \theta) = \mathcal{L}_{\text{discrete}}(\theta) \mathcal{L}_{\text{CT}}(\theta) \mathcal{L}_{\rho(S_n)}(\theta) \mathcal{L}_{\langle \Gamma_{\gamma 0} \rangle}(\theta).$$

- Constant temperature model extrapolation at the same time

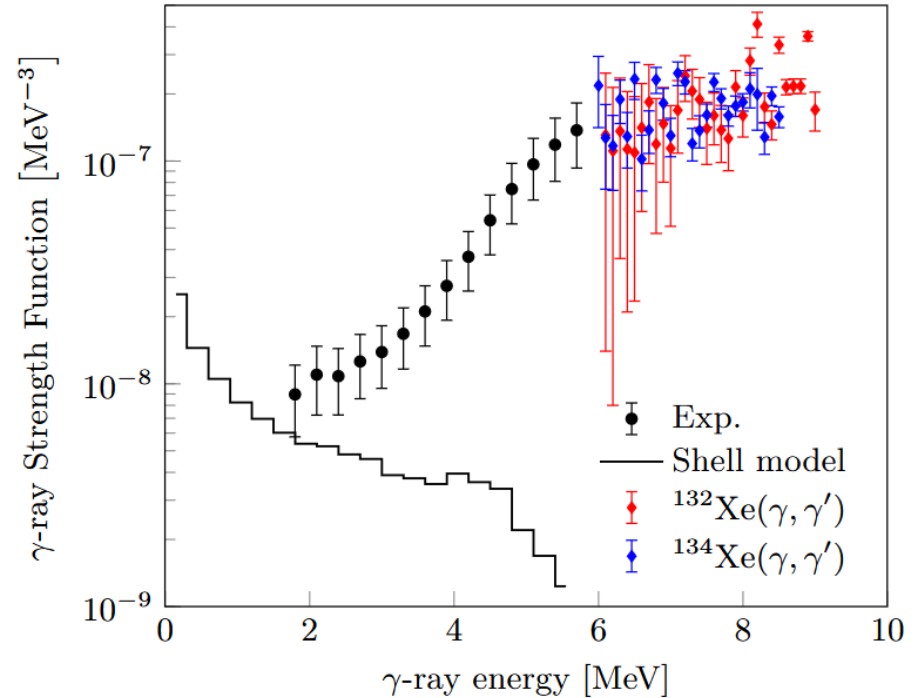


# Normalization

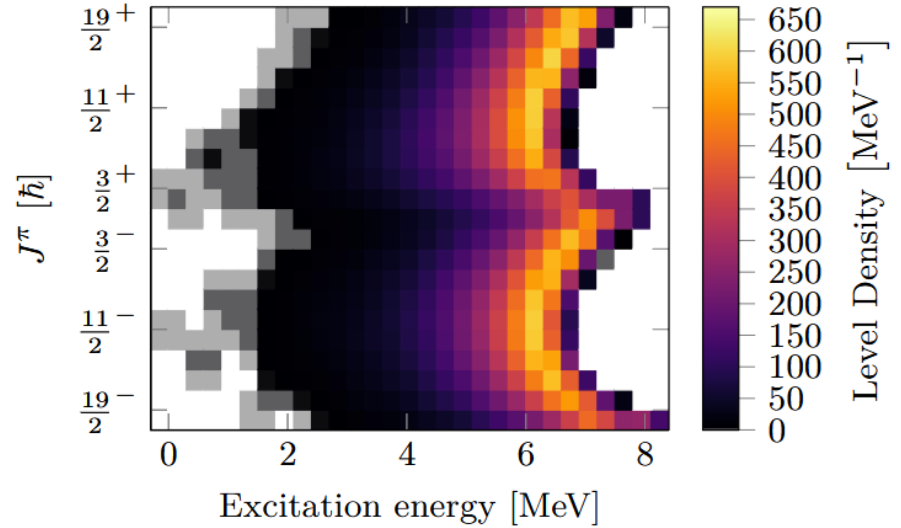
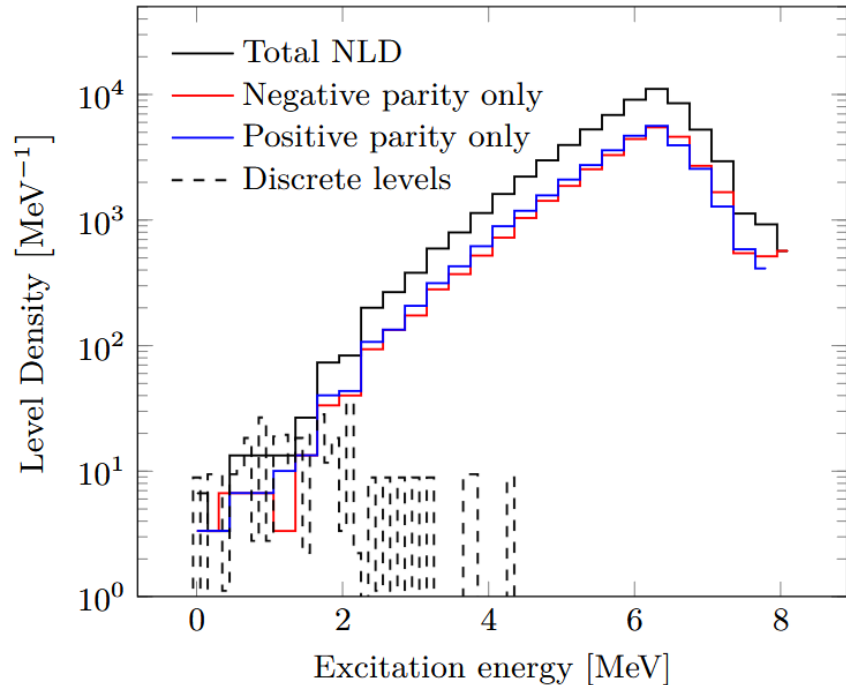
- Likelihood function to find parameters for normalization simultaneously

$$\mathcal{L}(\{\rho_i\}, \{f_i\} | \theta) = \mathcal{L}_{\text{discrete}}(\theta) \mathcal{L}_{\text{CT}}(\theta) \mathcal{L}_{\rho(S_n)}(\theta) \mathcal{L}_{\langle \Gamma_{\gamma 0} \rangle}(\theta).$$

- Constant temperature model extrapolation at the same time

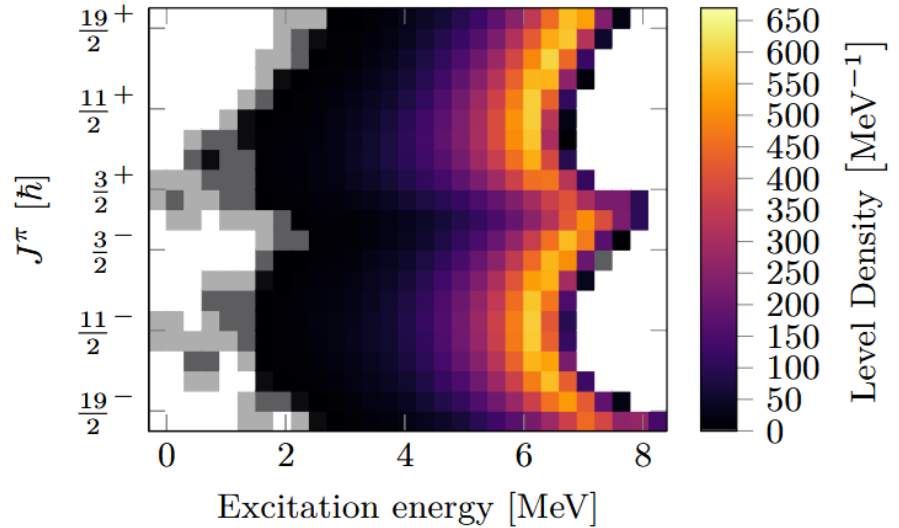
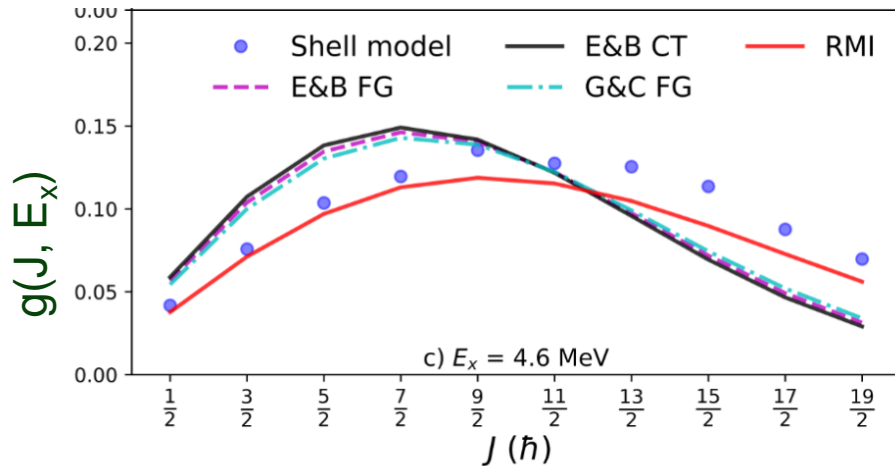


# Shell model calculations NLD



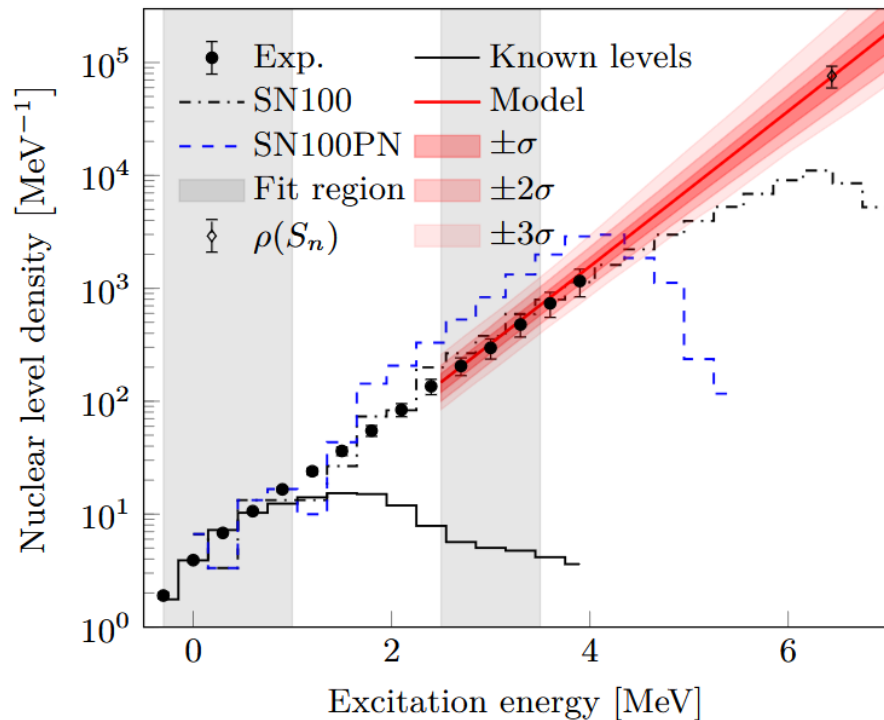
Allows us to look at spin dependence

# Shell model calculations NLD



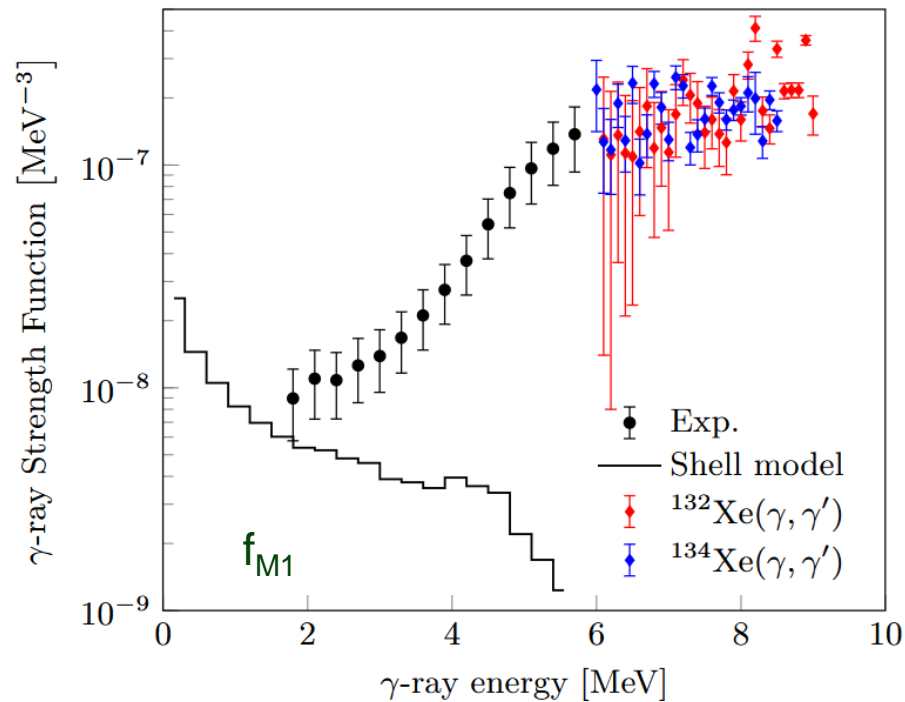
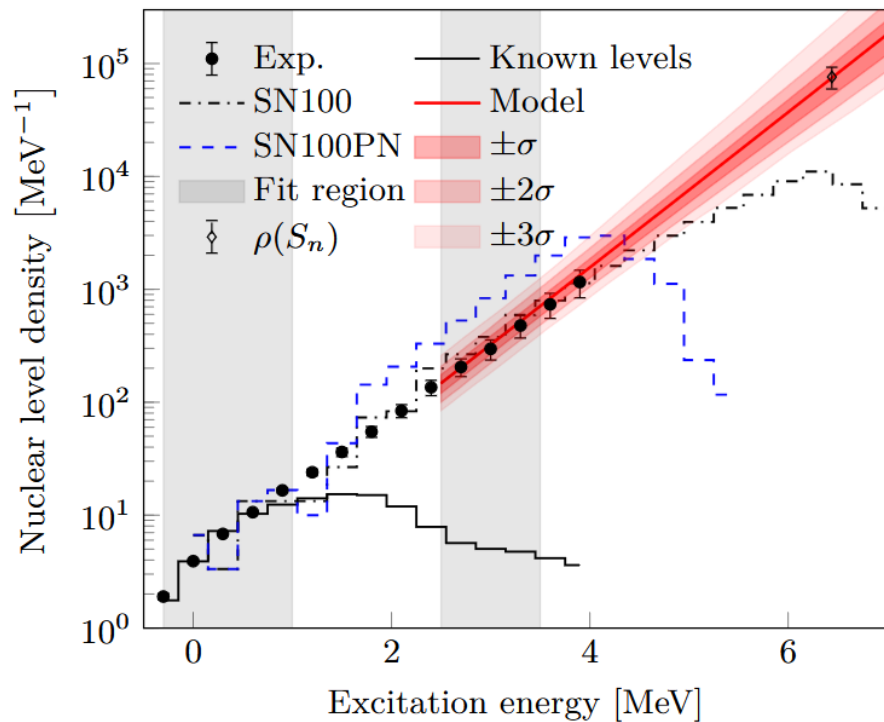
Allows us to look at spin dependence, inform spin cut-off parameter

# Shell model and experimental data



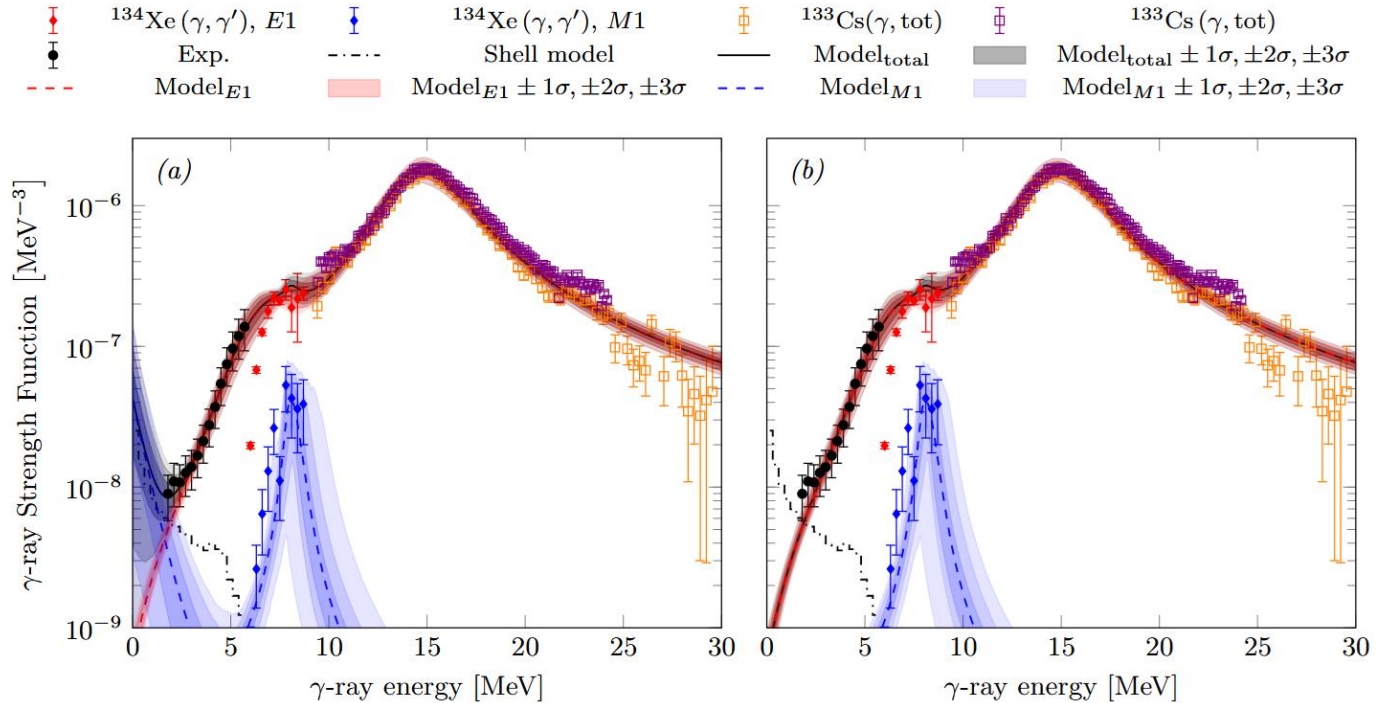
- Excellent agreement with our measured NLD for SN100
- SN100PN overshoots
- CT extrapolation higher than shell model prediction

# Shell model and experimental data

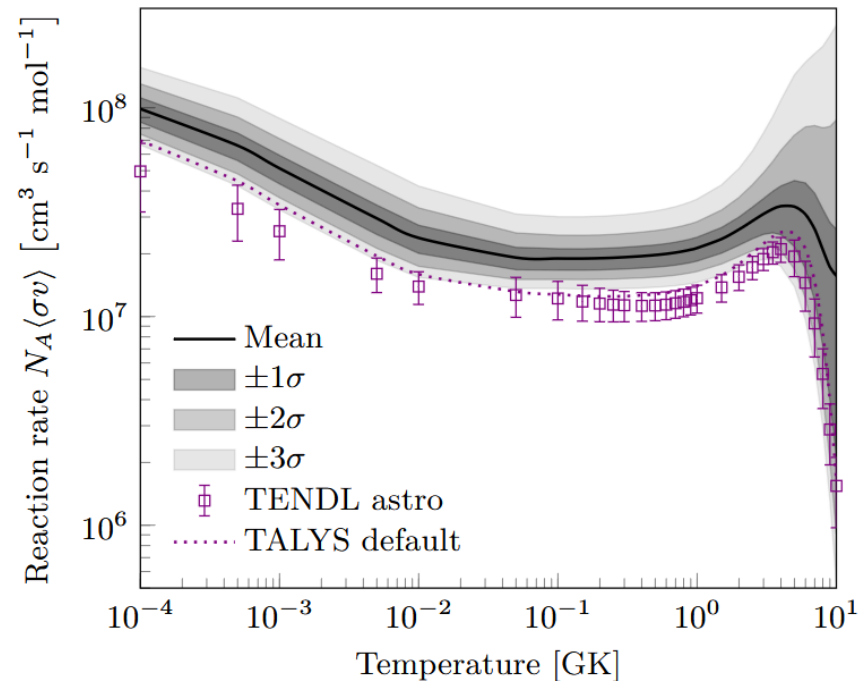
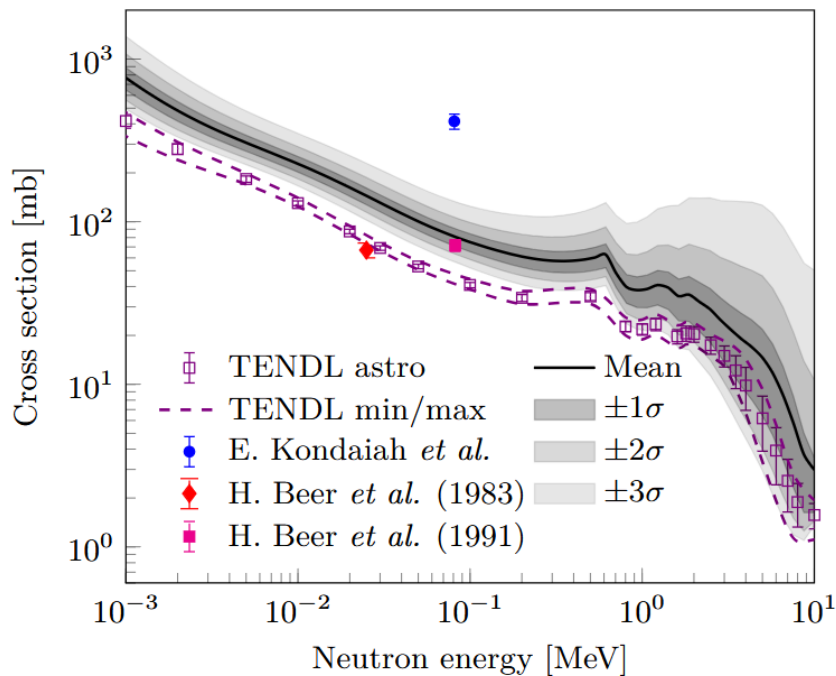


# gSF parametrization

Upbend or no upbend?



# Constraining neutron capture on $^{132}\text{Xe}$



# Thank you!

H. C. Berg,<sup>1,2,3,\*</sup> V. W. Ingeberg,<sup>3,4,†</sup> S. Siem,<sup>3,4</sup> M. Wiedeking,<sup>5,6,7</sup> D. L. Bleuel,<sup>8</sup> A. Ratkiewicz,<sup>8</sup>  
A. A. Avaa,<sup>7,‡</sup> C. P. Brits,<sup>7,9</sup> T. D. Bucher,<sup>7,10</sup> M. V. J. Chisapi,<sup>7,11</sup> J. K. Dahl,<sup>3,4</sup> A. Görgen,<sup>3,4</sup> P. Jones,<sup>7</sup>  
B. V. Kheswa,<sup>7,12</sup> K. L. Malatji,<sup>7,9,§</sup> B. Maqabuka,<sup>7,13</sup> J. E. Midtbø,<sup>3</sup> L. Msebi,<sup>13</sup> S. H. Mthembu,<sup>7,13</sup>  
G. O'Neill,<sup>14</sup> J. Ndayishimye,<sup>7,15</sup> L. Pellegrini,<sup>7,16</sup> T. Seakamela,<sup>7</sup> O. Shirinda,<sup>17</sup> and B. R. Zikhali<sup>7,18</sup>

<sup>1</sup>*Physics and astronomy, Michigan State University, East Lansing, 48824, MI USA*

<sup>2</sup>*Facility for Rare Isotope Beams, Michigan State University, East Lansing, MI 48824, USA*

<sup>3</sup>*Department of Physics, University of Oslo, N-0316 Oslo, Norway*

<sup>4</sup>*Norwegian Nuclear Research Centre, Norway*

<sup>5</sup>*Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*

<sup>6</sup>*School of Physics, University of the Witwatersrand, 2050 Johannesburg, South Africa*

<sup>7</sup>*iThemba LABS, P.O. Box 722, 7129 Somerset West, South Africa*

<sup>8</sup>*Lawrence Livermore National Laboratory, 7000 East Avenue, Livermore, California 94550-9234, USA*

<sup>9</sup>*Department of Physics, Stellenbosch University, P/B X1, Matieland, 7602, South Africa*

<sup>10</sup>*Department of Physics, University of Cape Town, Rondebosch, 7700, South Africa*

<sup>11</sup>*Department of Pure and Applied Physics, School of Natural and Applied Sciences,*

*University of Zambia P.O. Box 32379, Lusaka, Zambia*

<sup>12</sup>*Department of Physics, University of Johannesburg,*

*P.O. Box 524, Auckland Park 2006, South Africa*

<sup>13</sup>*Department of Physics, University of the Western Cape, P/B X17 Bellville 7535, South Africa*

<sup>14</sup>*Data Management and Software Centre, European Spallation Source ERIC, Copenhagen, Denmark*

<sup>15</sup>*Nuclear Technologies and Research Development,*

*Rwanda Atomic Energy Board, P. O. Box 4563, Kigali, Rwanda*

<sup>16</sup>*School of Physics, University of the Witwatersrand, Johannesburg 2050, South Africa*

<sup>17</sup>*Department of Physical and Earth Sciences, Sol Plaatje University, P/B X5008, Kimberley 8301, South Africa*

<sup>18</sup>*Department of Physics, University of Zululand, P/B X1001, KwaDlangezwa 3886, South Africa*

