

**Workshop on
Future of Gamma Spectroscopy at LNL:
GASP and CLARA Arrays**

Legnaro – Padova, March 3 to 5, 2004

**Investigation of Lifetimes for Dipole Bands of ^{141}Eu and
 ^{142}Gd with EUROBALL**

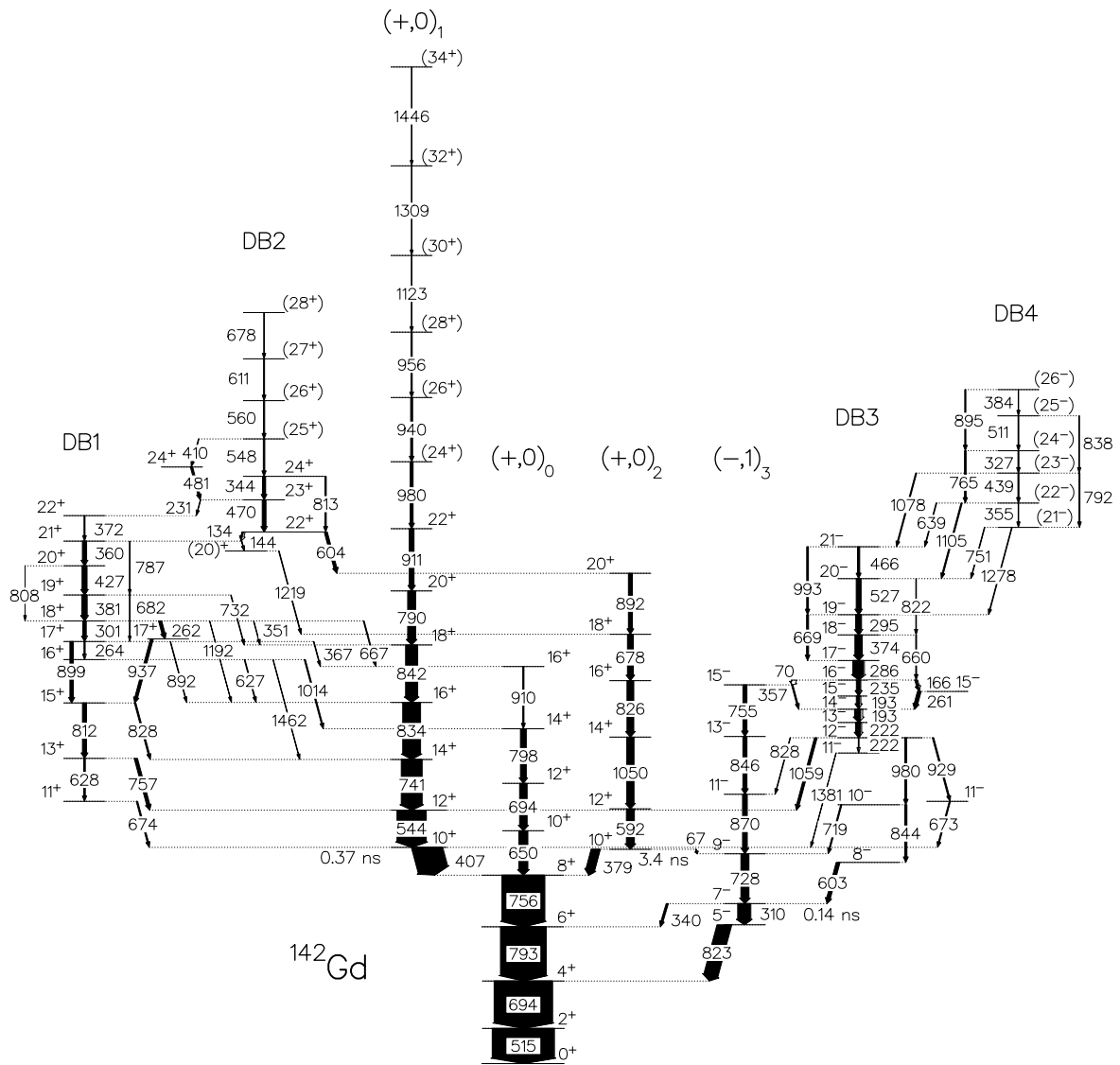
Rainer M. Lieder

Institut für Kernphysik
Forschungszentrum Jülich, Germany

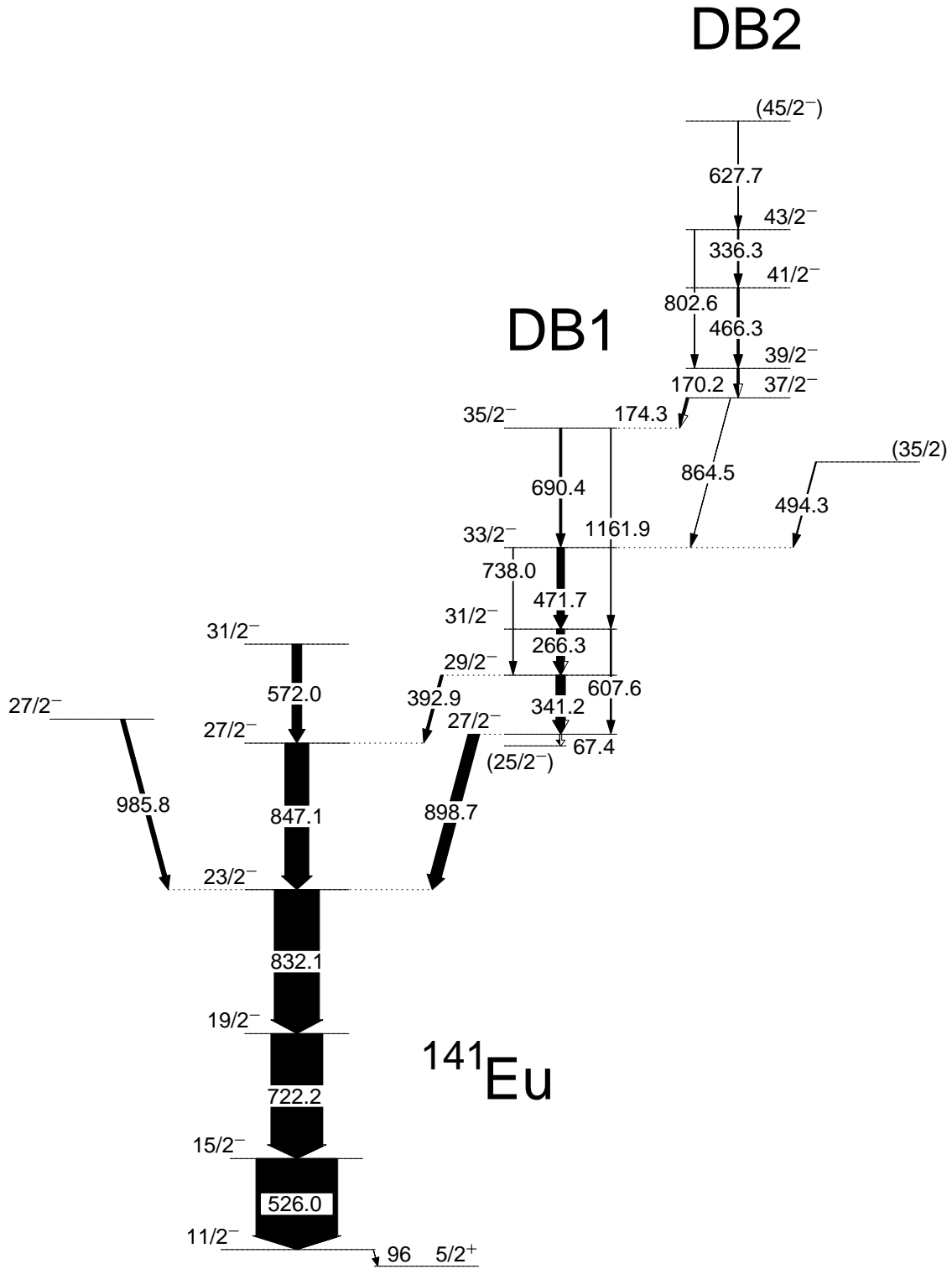
Outline

1. Observation of dipole bands in ^{141}Eu and ^{142}Gd
2. DSAM experiment to determine lifetimes for the dipole bands in ^{141}Eu and ^{142}Gd
3. Interpretation of the dipole bands in ^{141}Eu and ^{142}Gd in the framework of the TAC and SPAC models
4. Conclusions

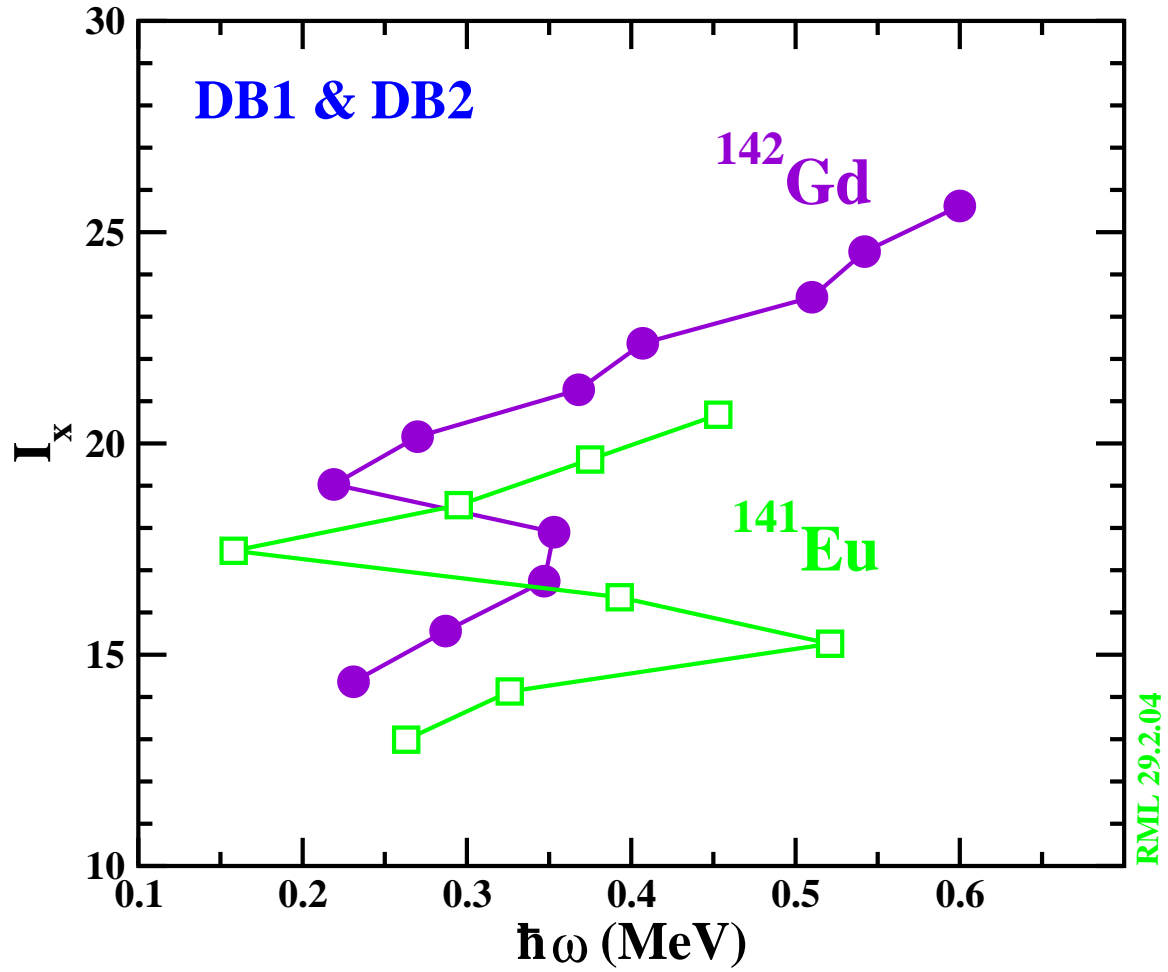
Level scheme of ^{142}Gd



Level scheme of ^{141}Eu



Total aligned angular momentum for DB1-2 in ^{141}Eu and ^{142}Gd



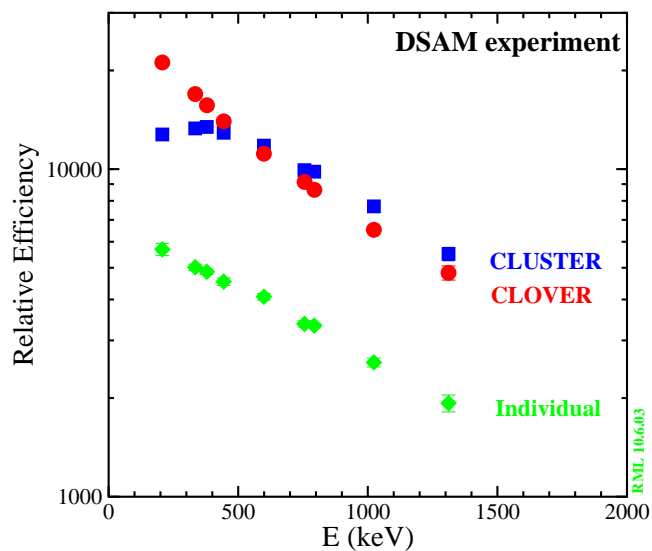
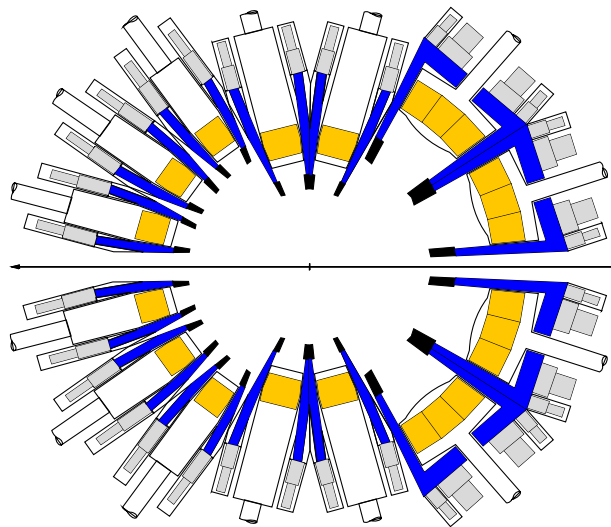
Lifetime measurement for ^{141}Eu and $^{142,143}\text{Gd}$ with EUROBALL IV using DSAM

Reaction: $^{114}\text{Sn}(^{32}\text{S}, ypxn)$
 $y = 2,3$ and $x = 1,2$

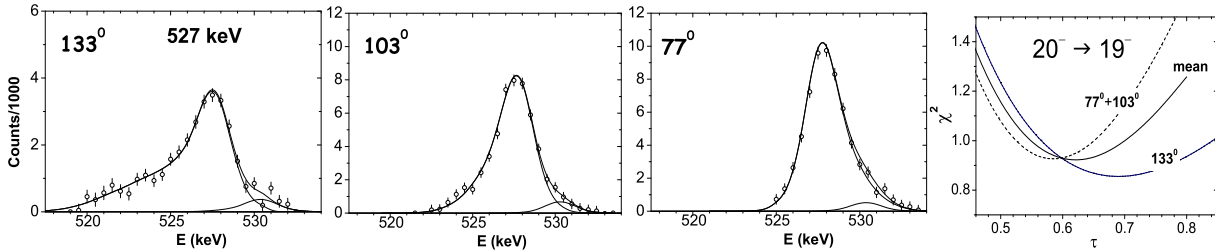
Beam Energy: 160 MeV

Target: Self-supporting foil of 8 mg/cm^2

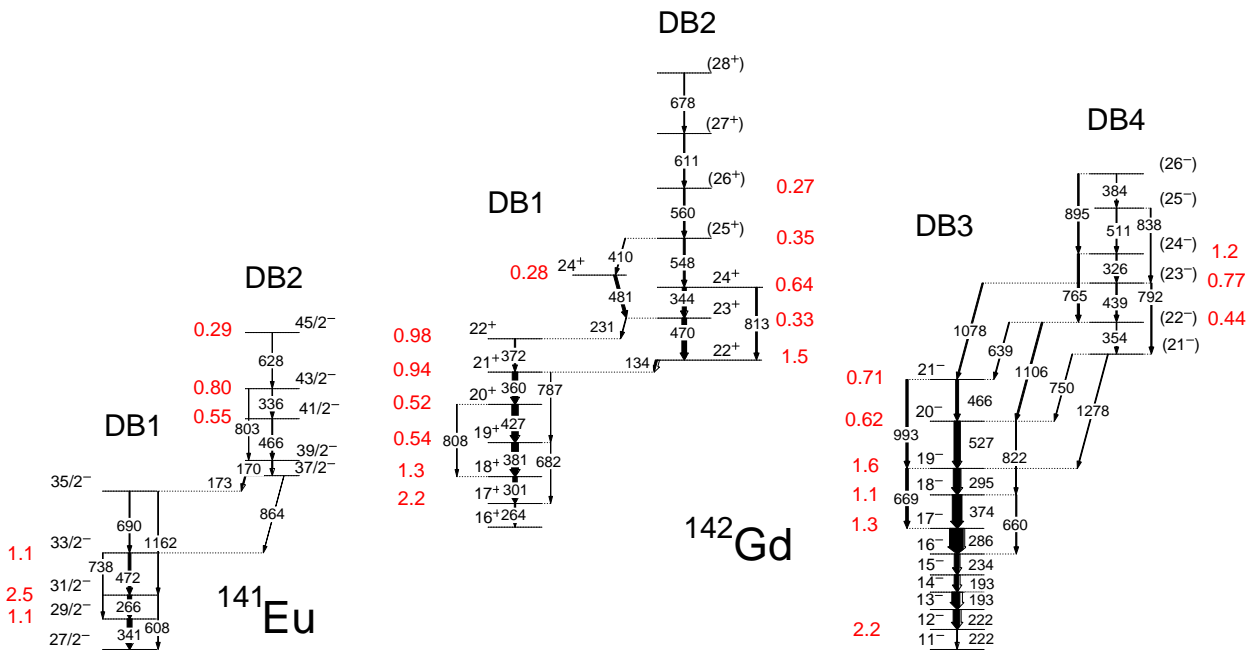
Recoil velocity: $v/c = 2.2\%$



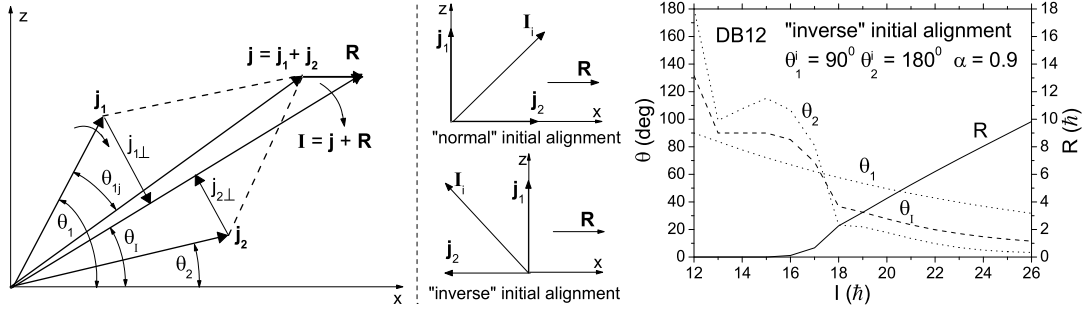
DSAM analysis for 527 keV $20^- \rightarrow 19^-$ transition in ^{142}Gd



Lifetime results for the dipole bands in ^{141}Eu and ^{142}Gd



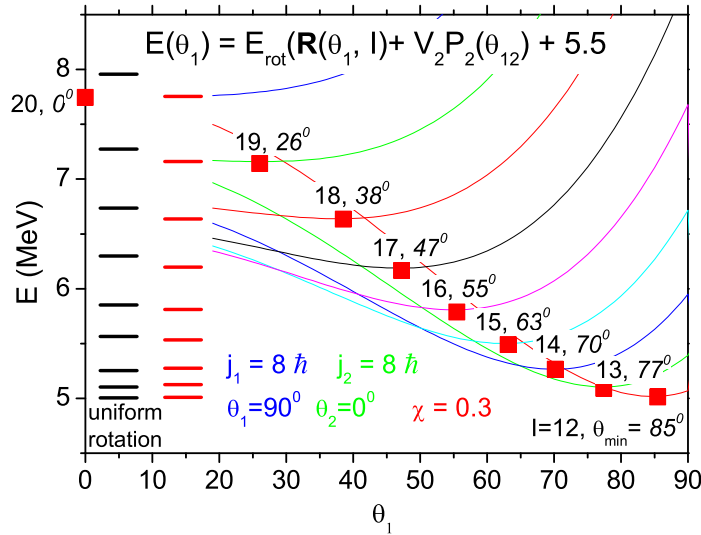
Shears mechanism with PAC (SPAC)



$$E(I, \theta_1, \theta_2) = \frac{1}{2\mathcal{J}} R^2(I, \theta_1, \theta_2) + V_2 P_2(\theta_1 - \theta_2) + const$$

$$R(I, \theta_1, \theta_2) = \sqrt{I^2 - (j_1 \sin \theta_1 + j_2 \sin \theta_2)^2} - j_2 \cos \theta_2 - j_1 \cos \theta_1$$

$$P_2(\theta_1 - \theta_2) = \frac{1}{2} [3 \cos^2(\theta_1 - \theta_2) - 1]$$



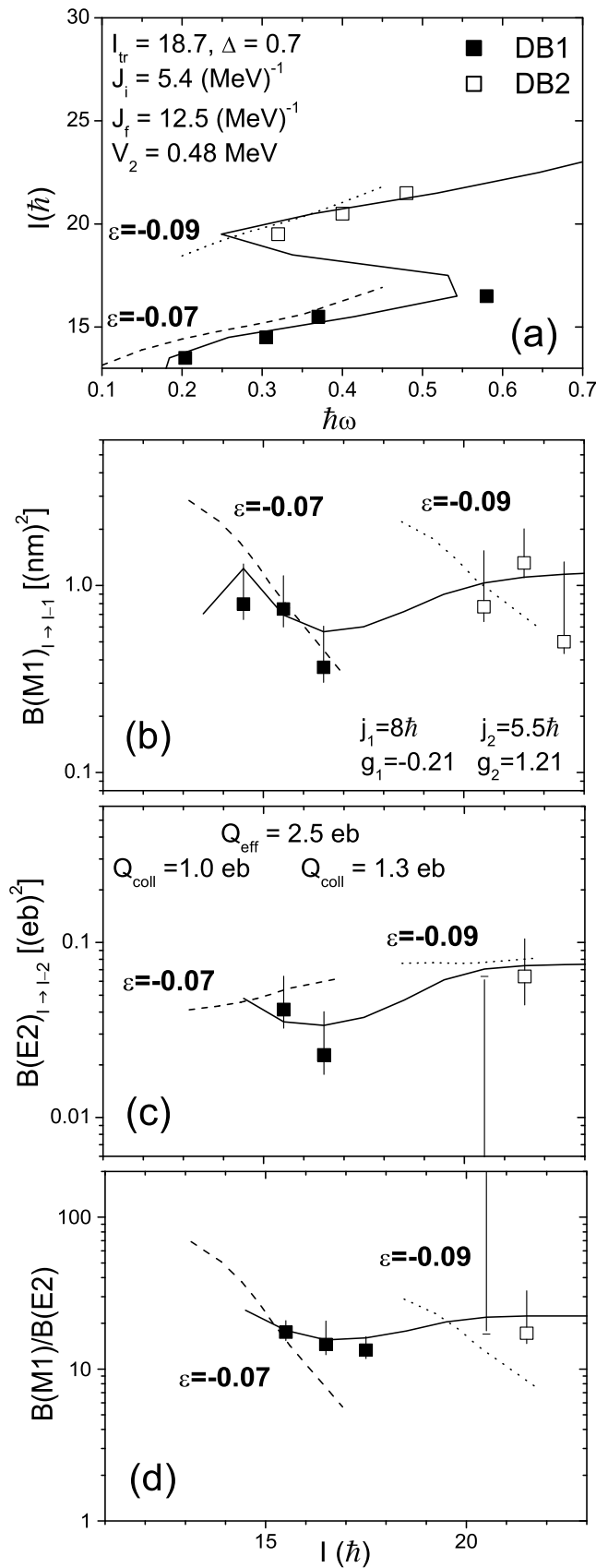
$$B(M1; I \rightarrow I - 1) = \frac{3}{8\pi} \mu_{\perp}^2$$

$$\mu_{\perp} = (g_1 - g_R) j_{1\perp} - (g_2 - g_R) j_{2\perp}, \quad g_R = Z/A$$

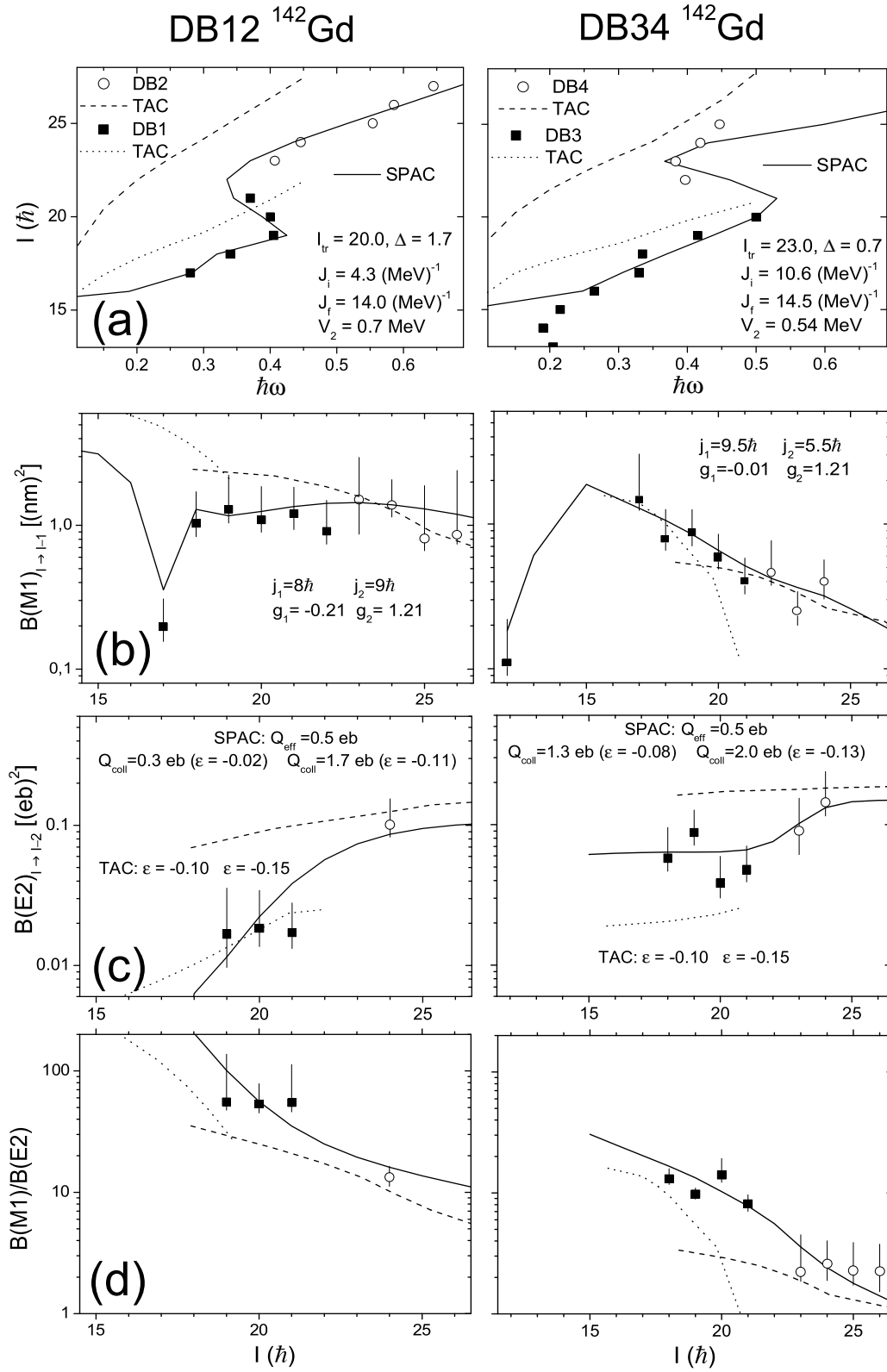
$$j_{1\perp} = j_1 \sin(\theta_1 - \theta_I), \quad j_{2\perp} = j_2 \sin(\theta_I - \theta_2)$$

$$B(E2; I \rightarrow I - 2) = \frac{15}{128\pi} [Q_{eff} \sin^2 \theta_{1j} + Q_{coll} \cos^2 \theta_I]^2$$

TAC and SPAC model results for ^{141}Eu



TAC and SPAC model results for ^{142}Gd



Summary

- Several dipole bands have been observed in each of the nuclei ^{141}Eu and ^{142}Gd
- Lifetimes have been extracted for the dipole bands in ^{141}Eu and ^{142}Gd
- The dipole bands in ^{141}Eu and ^{142}Gd can be interpreted as magnetic rotational bands from the generally good agreement between the experimental results and the results of TAC and SPAC model calculations.
- DB1 and DB3 in ^{142}Gd may have $\pi h_{11/2}^2 \otimes \nu h_{11/2}^{-2}$ and $\pi h_{11/2}^1 \otimes \pi g_{7/2}^{-1} \nu h_{11/2}^{-2}$ configurations, respectively
- DB2 and DB4 in ^{142}Gd may result from the breakup of a second $h_{11/2}$ neutron-hole pair
- DB1 and DB2 in ^{141}Eu may result from DB1 and DB2 in ^{142}Gd by subtraction of a $h_{11/2}$ proton

List of Collaborators

**E. Podsvirova¹, A. Pasternak¹, R.M. Lieder, W. Gast, H.M. Jäger,
L. Mihailescu**

Institut für Kernphysik, FZ Jülich, Germany

¹ *A.F. Ioffe Physical Technical Institute, St. Petersburg, Russia*

S. Chmel

Institut für Strahlen- und Kernphysik, University of Bonn, Germany

A. Dewald

Institut für Kernphysik, University of Cologne, Germany

D. Bazzacco, E. Farnea, S. Lunardi, R. Menegazzo, C. Rossi Alvarez

Dipartimento di Fisica dell'Università and INFN, Sezione di Padova, Italy

G. de Angelis, D.R. Napoli, A. Gadea

INFN, Laboratori Nazionali di Legnaro, Italy

Ts. Venkova

*Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of
Sciences, BG-1784 Sofia, Bulgaria*

W. Urban, Chr. Droste, T. Morek, T. Rzaça-Urban

Institute of Experimental Physics, University of Warsaw, Poland

G. Duchêne

Institut de Recherches Subatomique IReS, Strasbourg, France

R. Wyss

*Royal Institute of Technology, Physics Department Frescati, S-10405
Stockholm, Sweden*