

**Neutron-rich $^{62,64,66}\text{Fe}$ show enhanced Collectivity:
The Washout of $N=40$ in Terms of Experiment,
Valence Proton Symmetry and Shell Model**

W. Rother¹, A. Dewald¹, H. Iwasaki^{2,3}, S. Lenzi⁴, K. Starosta⁵, D. Bazin², T. Baugher^{2,3}, A. Brown^{2,3}, H. Crawford^{2,3}, C. Fransen¹, A. Gade^{2,3}, T. Ginter^{2,3}, T. Glasmacher^{2,3}, G. F. Grinyer², M. Hackstein¹, G. Ilie⁶, J. Jolie¹, S. McDaniel^{2,3}, B. Melon⁷, G. Pascovici¹, P. Petkov^{1,8}, Th. Pissulla¹, A. Ratkiewicz^{2,3}, C. A. Ur⁴, P. Voss^{2,3}, K. Walsh^{2,3}, D. Weisshaar^{2,3}, and K.O. Zell¹

¹Institut für Kernphysik der Universität zu Köln, 50937 Köln, Germany

²NSCL, MSU, East Lansing, Michigan 48824, USA

³Department of Physics and Astronomy, MSU, East Lansing, Michigan 48824, USA

⁴Dipartimento di Fisica dell' Università and INFN, Sezione di Padova, Padova, Italy

⁵Department of Chemistry, Simon Fraser University, Burnaby BC V5A 1S6, Canada

⁶WNSL, Yale University, New Haven, Connecticut 06520, USA, and

National Institute of Physics and Nuclear Engineering, 76900 Bucharest, Romania

⁷Dipartimento di Fisica, Università di Firenze and INFN, Sesto Fiorentino, 50019, Italy

⁸Institute for Nuclear Research and Nuclear Energy, BAS, 1784 Sofia, Bulgaria

Probing shell structure at a large neutron excess has been of particular interest in recent times. Neutron-rich nuclei between the proton shell closures $Z=20$ and $Z=28$ offer an exotic testing ground for shell evolution. The development of the $N=40$ gap between neutron fp and $1g_{9/2}$ shells gives rise to highly interesting variations of collectivity for nuclei in this region.

While ^{68}Ni shows doubly magic properties in level energies and transition strengths, this was not observed in neighbouring nuclei. Especially neutron-rich Fe isotopes proved particularly resistant to calculational approaches using the canonical valence space (fp) resulting in important deviations of the predicted collectivity. Only an inclusion of the $d_{5/2}$ -orbital could solve the problem [1]. Hitherto no transition strengths for ^{66}Fe have been reported.

We determined $B(E2, 2^+_1 \rightarrow 0^+_1)$ values from lifetimes measured with the recoil distance Doppler-shift method using the Cologne plunger for radioactive beams at National Superconducting Cyclotron Laboratory at Michigan State University. Excited states were populated by projectile Coulomb excitation for $^{62,64,66}\text{Fe}$.

The data show a rise in collectivity for Fe isotopes toward $N=40$. Results are interpreted by means of a modified version of the Valence Proton Symmetry [2] and compared to scale shell model calculations using a new effective interaction recently developed for the fp valence space.

[1] E. Caurier *et al.*, Eur. Phys. J **A15**, 145 (2002)

[2] A. Dewald *et al.*, Phys. Rev. C **78**, 051302(R) (2008).