A New Proposal to the High Intensity Gamma-Ray Source (HIγS) PAC-10

Energy separation of the $1^+/1^-$ parity-doublet in $^{20}$Ne

N. Pietralla (Spokesperson-Contact), J. Isaak, C. Romig, D. Savran, K. Sonnabend, M. Zweidinger
IKP, TU Darmstadt, Schloßgartenstr. 9, 64289 Darmstadt, Germany

H.R. Weller (Spokesperson), E. Kwan, R. Raut, G. Rusev, A. Tonchev, W. Tornow
Department of Physics, Duke University, Durham, North Carolina 27708-0308, USA

J. Kelley
Department of Physics, North Carolina State University, Raleigh, North Carolina 27695-8202, USA

May 7, 2010
1 Experiment Summary

We propose to measure the excitation energy difference of the parity-doublet of $1^+/1^-$ levels in $^{20}$Ne at 11.26 MeV at the High Intensity $\gamma$-Ray Source (HI$\gamma$S). The doublet has been suggested [1] as one of the best known test cases for studying parity violation in atomic nuclei. The single-particle structure of these $T = 1$ dipole excitations is quite simple because they are isobaric analogue states to the structure near the ground state of $^{20}$F. The parity doublet in $^{20}$Ne therefore offers an extraordinary opportunity to test the impact of weak interaction on nuclear structure quantitatively.

Recently, scattering of circularly polarized photons on strongly excited parity-doublets has been proposed as a promising tool for parity violation studies. The feasibility of such an experiment depends on the value of the so-called effective nuclear enhancement factor $|R_N/\Delta E|$ which is proportional to the weak interaction matrix element divided by the energy splitting. For the doublet in $^{20}$Ne an extremely large enhancement factor of $|R_N/\Delta E| = (670 \pm 7000)$ has been reported [1] making $^{20}$Ne to an ideal test case. However, the uncertainty is large and it is thus the intention of the proposed experiment to determine $|R_N/\Delta E|$ with much higher precision.

The large error of $|R_N/\Delta E|$ is mainly caused by the uncertainty of $\Delta E$ of the $1^-$ and $1^+$ parity-doublet, which is difficult to determine since the levels are very close to each other. A nuclear resonance fluorescence (NRF) experiment using linearly polarized photons at HI$\gamma$S will allow a much more precise determination of the energies due to the different azimuthal angular distributions of the $0^+ \rightarrow 1^- \rightarrow 0^+$ and $0^+ \rightarrow 1^+ \rightarrow 0^+$ transitions.

We ask for 3 days of beam time at 11.26 MeV and one setting at a nearby energy (see Experiment Description).