Collective Quadrupole Behavior in $^{106}$Pd: A Comprehensive Examination

S.W. Yates$^{1,2}$, E.E. Peters$^1$, F.M. Prados-Estévez$^{1,2}$, A. Chakraborty$^{1,2}$, M.G. Mynk$^1$, D. Bandyopadhyay$^2$, N. Boukharouba$^3$, S.N. Choudry$^2$, B.P. Crider$^2$, P.E. Garrett$^3$, S.F. Hicks$^4$, A. Kumar$^2$, S.R. Lesher$^2$, C.J. McKay$^2$, M.T. McEllistrem$^2$, S. Mukhopadhyay$^2$, J.N. Orce$^{2,5}$, M. Scheck$^{2,6}$, J.R. Vanhoy$^{2,7}$ and J.L. Wood$^8$

$^1$Department of Chemistry, University of Kentucky, Lexington, KY 40506, USA
$^2$Department of Physics & Astronomy, University of Kentucky, Lexington, KY 40506, USA
$^3$Department of Physics, University of Guelph, Guelph, Ontario, N1G2W1, Canada
$^4$Department of Physics, University of Dallas, Irving, TX 75062, USA
$^5$Department of Physics, University of the Western Cape, P/BX17, ZA-7535, South Africa
$^6$School of Engineering, University of the West of Scotland, High Street, Paisley PA1 2BE, UK; SUPA, Scottish Universities Physics Alliance, Glasgow G12 8QQ, United Kingdom
$^7$Department of Physics, United States Naval Academy, Annapolis, MD 21402, USA
$^8$School of Physics, Georgia Institute of Technology, Atlanta, GA 30332, USA

Quadrupole shape vibrations have long been considered to be a fundamental degree of freedom of nuclei. Several candidates in the $^{48}$Cd and $^{46}$Pd region have been proposed as examples of good quadrupole shape vibrators; however, in studies of $^{112,114,116}$Cd [1,2,3] and $^{106,108,110}$Pd [4], serious discrepancies from the vibrational decay pattern were found, suggesting a breakdown of the quadrupole vibrational picture. It has been suggested [5] that these nuclei are closer to a $\gamma$-soft rotor rather than a vibrator, and the observation of $E_0$ transitions in $^{106}$Pd provides evidence for shape coexistence [6]. It is expected that studies of the Cd and Pd isotopes will bring new insights into their structure and will clarify the limitations of the traditional models of nuclear structure.

Inelastic neutron scattering is a powerful tool for the study of nuclei due to its non-selective nature, which allows the observation of non-yrast states that may not be populated in other types of reactions. The low-lying, low-spin states of $^{106}$Pd have been studied with the (n,n'\gamma) reaction at the University of Kentucky Accelerator Laboratory. Excitation functions measured with neutrons of energies ($E_n$) from 2.0 to 3.8 MeV in 0.1-MeV steps, $\gamma$-ray angular distributions at $E_n=2.2$, 2.7 and 3.5 MeV, and $\gamma-\gamma$ coincidences at $E_n=3.3$ MeV were used to characterize the decays of the excited states in $^{106}$Pd. Level lifetimes were measured by the Doppler-shift attenuation method (DSAM).

This material is based upon work supported by the U.S. National Science Foundation under Grant No. PHY-1606890.