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A. F. García-Flores  
*Pennsylvania State University*

Dmitri A. Tenne  
*Boise State University*

W. J. Ren  
*Chinese Academy of Sciences*

X. X. Xi.  
*Pennsylvania State University*

S.-W. Cheong  
*Rutgers University*
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A.F. García-Flores$^{a,b,c}$, D.A. Tenne$^b$, W.J.. Ren$^e$, X.X.X. Xi$^a$, and 
S.-W. Cheong$^d$

$^a$Department of Physics, the Pennsylvania State University, University Park, Pennsylvania 16802 
$^b$Department of Physics, Boise State University, Boise, Idaho 83725-1570 
$^c$Instituto de Física “Gleb Wataghin”, UNICAMP, C.P. 6165, 13083-970, Campinas-SP, Brazil 
$^d$Department of Physics and Astronomy, Rutgers University, Piscataway, New Jersey 08854, USA 
$^e$Shenyang National Laboratory for Materials Science, Institute of Metal Research and International 
Centre for Materials Physics, Chinese Academy of Sciences, Shenyang 110016, People’s Republic of 
China

Among complex perovskite-type structure multiferroics [A(B’B”’)O$_3$], lead iron niobate Pb(Fe$_{1/2}$Nb$_{1/2}$)O$_3$ (PFN) discovered by Smolenskii et al.$^1$ is currently of interest because of its high dielectric constant diffuse phase transition$^2$ and magnetoelectric effect$^3$.$^4$. PFN presents ferroelectric transition below $T_C$~350-395 K and antiferromagnetic transition below $T_N$~145 K$^1$-$^4$.

In PFN, the Pb$^{2+}$ cations with a lone electron pair in A site and the relative displacements of oxygen and Fe$^{3+}$/Nb$^{5+}$ ions in the octahedral B sites favor the electric ordering whereas the Fe$^{3+}$ cations with partially filled $d$ orbitals contribute to the magnetic ordering. Because of its complex structure, still exists a disagreement about the crystalline structure of PFN: monoclinic (space group Cm), rhombohedral (space group R3m), and cubic (space group Pm3m) structure symmetry at room temperature were reported$^3$.$^5$.$^6$.

In this work, we report temperature-dependent Raman spectra (10-500 K) in the frequency range of 150-1250 cm$^{-1}$ of cubic PFN single crystals, complemented with magnetization measurements. We want to provide microscopic information in this material.

Over the range from 150 to 950 cm$^{-1}$, very broad and overlapping peaks (first-order character) were observed in the overall studied temperature range possibly due to local distortions which are characteristic in this kind of Pb-based complex perovskite. Also, a prominent high-frequency peak at ~1130 cm$^{-1}$, which we assign as a two-phonon peak, was observed (see Fig. 1).

Temperature dependence of the Raman spectra showed an anomaly in a characteristic temperature $T^* \sim 330$ K. Here, drastic changes in the Raman scattering intensity and spectral shape were observed with temperature variations, such as the appearance of new first- and second- order peaks below $T^*$. The temperature behavior of the two-phonon peak shows a strong electron-phonon interaction in PFN. Also, since it was reported weak magnetic ordering at and even above room temperature in
this material, the anomaly at $T^* \approx 330$ K by Raman scattering could be possibly suggesting an interplay between magnetic and ferroelectric orders.

![Raman spectra as a function of temperature in Pb(Fe\textsubscript{1\textsubscript{2}}Nb\textsubscript{1\textsubscript{2}})O\textsubscript{3}.](image.png)

**Figure 1: Raman spectra as a function of temperature in Pb(Fe\textsubscript{1\textsubscript{2}}Nb\textsubscript{1\textsubscript{2}})O\textsubscript{3}.**

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**REFERENCES**