Q-domains in Multiferroic CoCr$_2$O$_4$ THOMAS A. KAPLAN, Michigan State University — In spinel CoCr$_2$O$_4$, the observed spin state at low temperature is, approximately, a “ferrimagnetic spiral”$^1$, given by$^2$ $S_{n\nu} = \sin \theta_{\nu}[\hat{x} \cos(Q \cdot R_{n\nu} + \gamma_{\nu}) + \hat{y} \sin(Q \cdot R_{n\nu} + \gamma_{\nu})] + \cos \theta_{\nu} \hat{z} \cdot \nu = 1 \cdots 6$ goes over the six magnetic fcc sublattices, $R_{n\nu}$ are the positions of the magnetic ions, $\hat{z} = [001]$ crystallographic direction, $\theta_{\nu}$ are the cone half-angles on which the spins lie, and $\gamma_{\nu}$ are the phases of the 6 conical spirals, all with wave vector $Q$ in the [110] direction. This yields magnetization $M^1$, and, via the Katsura et al mechanism$^3$, electric polarization $P^4$. Equivalent $Q$’s, e.g. $\pm Q$, with associated $M$’s and $P$’s, are expected to give degenerate states, “$Q - M - P$ domains”; poling in electric and magnetic fields selects a single such domain. Reversal of magnetic field then leads to $P$ reversal$^4,5$ and $Q$ reversal$^5$. But $Q \rightarrow -Q$ in the equation above does not appear to give a degenerate state. I show, via the Heisenberg model and the Generalized Luttinger-Tisza method used in the prediction of the spin state,$^2$ that $\gamma_{\nu} \rightarrow -\gamma_{\nu}$ on $Q$ reversal, making manifest the $Q \rightarrow -Q$ degeneracy.

$^1$N. Menyuk et al., J. de Physique 25, 528 (1964)  
$^5$Y. J. Choi et al, submitted for publication

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