Borderline magnetism in Sr$_4$Ru$_3$O$_{10}$: Impact of dilute La and Ca doping on itinerant metamagnetism and ferromagnetism$^1$ SHALINEE CHIKARA, V. DURAI RAJ, W.H. SONG, Y.P. SUN, X.N. LIN, A. DOUGLASS, G. CAO, University of Kentucky — The triple-layered Sr$_4$Ru$_3$O$_{10}$ features ferromagnetic behavior with T$_c$=105 K along the c-axis (interlayer) and a first-order metamagnetic transition below 50 K in the basal plane [1]. The coexistence of ferromagnetism and metamagnetism suggests Sr$_4$Ru$_3$O$_{10}$ be on the borderline that separates its closest neighbors: the itinerant ferromagnet SrRuO$_3$ and the enhanced paramagnet Sr$_3$Ru$_2$O$_7$. We report our results on Sr$_4$Ru$_3$O$_{10}$ with Sr slightly substituted by La and Ca ions. The La doping drastically changes the magnetic and transport properties. In particular, it effectively suppresses T$_c$ along the c-axis, but simultaneously induces ferromagnetic behavior in the basal plane with T$_c$=30 K, entirely different from that of the c-axis. Associated with these changes, the metamagnetism disappears in the basal plane but appears along the c-axis. In sharp contrast, the Ca doping significantly enhances the ferromagnetism along c-axis but drastically weakens the magnetic ordering in the basal plane where an unusual T$_c$=0.2 power law for the resistivity is developed. The vastly different responses to the La and Ca doping, despite similar ionic radii of La$^{3+}$ and Ca$^{2+}$, highlight the role of the extra electron from the La ion added to the t$_{2g}$ orbitals. [1] G. Cao, et al., Phys. Rev. B 68 174409 (2003)

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