Frustrated S = 1/2 square lattice systems in complex Vanadium oxides

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The frustrated spin square lattice system has attracted strong theoretical attention since an interesting phase diagram and unusual ground states are expected depending on the relation between J_1 (nearest neighbor exchange) and J_2 (diagonal frustrating exchange). However, experimental studies are very limited because of the absence of appropriate compounds. The first example for the realization of such a lattice, $Li_2VO(Si/Ge)O_4$, was found only quite recently. Further on, the ratio J_1/J_2 in this compound is controversial, more recent investigations suggest the frustration to be very weak.
We found a new series of compound, $AA´VO(PO_4)_2$, with A, A´= Zn, Pb, Sr, Ba, where the structural data as well as susceptibility $\chi(T)$ and specific heat C(T) data suggest such a frustrated square lattice to be realized. However, a detailed analysis of our $\chi(T)$ and C(T) data using high temperature series expansion demonstrates that in these compounds, J_1 is ferromagnetic while J_2 is antiferromagnetic, $|J_2|$ being larger than $|J_1|$. These systems are thus the first examples for a frustrated spin square lattice system with a ferromagnetic nearest neighbor exchange. The frustration is changing quite strongly with the A and A´ cations, being strongest in $SrZnVO(PO_4)_2$ where $|J_1| \cong |J_2|$. Our results prompted the theoretical investigation of the J_1-J_2 model with ferromagnetic J_1, since such a constellation was yet barely considered.