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Magnetic nanopantograph in the in $SrCu_2(BO_3)_2$ Shastry-Sutherland lattice

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Magnetostriction experiments of the frustrated spin dimer compound $SrCu_2(BO_3)_2$ have shown that its macroscopic physical dimensions change with the applied magnetic field mimicking the complicated structures, with discreet jumps and plateaus, observed in the magnetization. Using Density Functional based methods we find that the driving force behind the magnetoelastic coupling is the Cu-O-Cu superexchange angle which, thanks to the orthogonal Cu^{2+} dimers acting as pantographs, can shrink significantly (0.44%) with minute (0.01%) variations in the lattice parameters. Our calculations show that the consequence is a reduction of the order of $\sim$10% in the antiferromagnetic intra-dimer exchange integral J, sufficient to compensate the elastic energy loss in the deformation. This reduction should impact our reading of existing predictions of the magnetization versus field phase diagram and the effect of hydrostatic pressures on the ground state. Finally, our prediction of the dimer shrinking under applied magnetic field should appear as a modification of the optical Raman active modes compatible with the pantograph effect.