Low Energy Dynamics of Spin-Liquid and Ordered Phases of S=1/2 Antiferromagnet Cs_2CuCl_4

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Spin-1/2 antiferromagnet Cs_2CuCl_4 consists of weakly coupled 2D layers realizing distorted triangular lattice. In the temperature interval between the Curie-Weiss (4 K) and the ordering Néel (T_N= 0.6 K) temperatures, the spins form a correlated spin-liquid state. We report electron spin resonance (ESR) measurements of Cs_2CuCl_4 in the frequency interval $9<f<140$ GHz and down to the temperature of 0.05 K. We observed an unexpected energy gap of about 14 GHz and a splitting of the ESR in the paramagnetic spin-liquid phase. Both the shift and the splitting of the ESR signal, as well the pronounced sensitivity to the polarization of microwave radiation, can be explained by considering the one-dimensional spinon excitations in presence of a uniform Dzyaloshinskii-Moriya (DM) interaction. This DM interaction provides an effective magnetic field, the sign of which is different for the right- and left-moving spinons. This causes the shift and splitting of the ESR. On cooling below T_N the described spinon-ESR response is found to survive deep in the ordered phase for $f>50$ GHz , while at lower frequencies the ESR response is strongly modified. We observe a gradual crossover from the low-energy spectrum of a spiral-ordered antiferromagnet to the spinon-type spectrum of a quasi-1D spin liquid at higher energies. Our experiments demonstrate a novel way to probe fractionalized spinon excitations.