The magnetic exciton in antiferromagnetic van der Waals $Ni_{1-x}Cd_xPS_3$

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The magnetic van der Waals $NiPS_3$ is a rare material for the magnetic state based exciton physics in magneto-optical field. The extremely narrow linewidth arising coherently from the localized Zhang-Rice singlet and triplet states was observed by the photoluminescence (PL) and the optical absorption in the single crystal $NiPS_3$ [1]. This locality in NiS_6 cluster is expected to give a stability of the coherent behavior to the disturbance of the close environment. Here, we newly synthesized the antiferromagnetic van der Waals $Ni_{1-x}Cd_xPS_3$ which have the non-magnetically doped Cd sites replaced in the Ni sites homogeneously throughout the whole crystal. The coherent behavior of Full-Width-Half-Maximum and the magnetic exciton's energy of PL is maintained up to a very low Cd concentration below $x = 0.005$. The localized excitons was formed in the magnetically ordered state within the range $x = 0 \sim 0.1$ as the magnetic susceptibility revealed together with linearly decreasing Neel temperature. In our work, we showed that the decoherence started from the $x = 0.01$ which may imply that the local physics changes by the non-magnetic spatial environment even in the magnetically ordered system.

[1] S. Kang et al., Nature 583, 285 (2020)