Large nonreciprocal optical responses in antiferromagnets with broken space-inversion and time-reversal symmetries

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Materials with broken space-inversion and time-reversal symmetries, such as magnetoelectric materials and chiral-lattice magnets, can exhibit variety of unconventional phenomena. A prominent example of such phenomena is the so-called nonreciprocal directional dichroism (NDD), that is, the difference in light absorption between two counter-propagating light beams [1,2]. The NDD has attracted considerable attention, for example in view of potential applications for novel nonreciprocal optical devices allowing the control of light propagation. Intensive studies in the past few decades have led to observations of NDD in many materials and broad wavelength regions [1-6]. However, reported NDD signals in the visible to near-infrared light regions are usually small [5] or require high magnetic fields to amplify the magnitude [4,6].

In my talk, after introducing fundamental features of NDD and previous studies, I will show our strategy to explore magnetoelectric materials showing large NDD signals in the visible to near-infrared regions. Then, I will present our recent achievements of the discovery of large visible-light NDD signals in a magnetoelectric antiferromagnet Bi$_2$CuO$_4$ [7]. Unlike most of previous observations, the large NDD signals of this material emerge spontaneously without external fields. Moreover, by switching multiple antiferromagnetic domains in this material with an external field, we have succeeded in demonstrating a highly unique magneto-optical functionality, that is, the three-level control of optical transparency. Finally, the results of even larger NDD signals in the near-infrared region in other magnetoelectric antiferromagnets will also be presented.


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