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Cosmic Birefringence Triggered by Dark Matter Domination

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Recently, the Planck 2018 polarization data of cosmic microwave background (CMB) radiation suggested the non-zero rotation angle of CMB polarization plane, which is called cosmic birefringence. Cosmic birefringence is predicted if an axion-like particle (ALP) moves after the recombination. We show that this naturally happens if the ALP is coupled to the dark matter density because it then acquires a large effective mass after the matter-radiation equality. Our scenario applies to a broad range of the ALP mass, even smaller than the present Hubble constant. We give a simple model to realize this scenario where dark matter is made of hidden monopoles which give the ALP such a large effective mass through the Witten effect. The mechanism works if the ALP decay constant is of order the GUT scale without a fine-tuning of the initial misalignment angle.

Presenter: NAKAGAWA, Shota

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