Basic Research

First Results from LHAASO's Dark Matter Search Place Tighter Constraints on Dark Matter's Lifetime

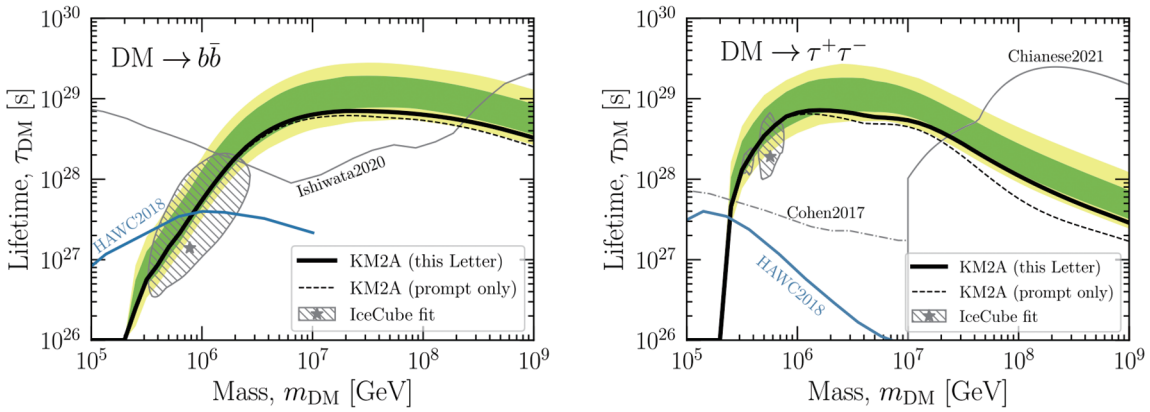
Scientists from the Large High Altitude Air Shower Observatory (LHAASO) have presented roughly 1.5 years of observational data, calculating new constraints on the lifetime of heavy dark matter particles that have masses between 10^5 and 10^9 giga-electron volts. The study, entitled "Constraints on heavy decaying dark matter from 570 days of LHAASO observations", was recently published as a highlight letter in *Physics Review Letter*.

Till now, people have never stopped pursuing the mysteries of dark matter, including its basic properties. The gravitational model of the Milky Way shows that there is a very high density of dark matter in the galactic center, and the gamma rays produced by the decay of this dark matter will radiate from the galactic center to the surroundings for hundreds of light-years or even thousands of light-years. However, for a long time, the observation of ultra-high-energy gamma rays produced by heavy dark matter has faced great challenges, mainly because of the presence of other background radiation.

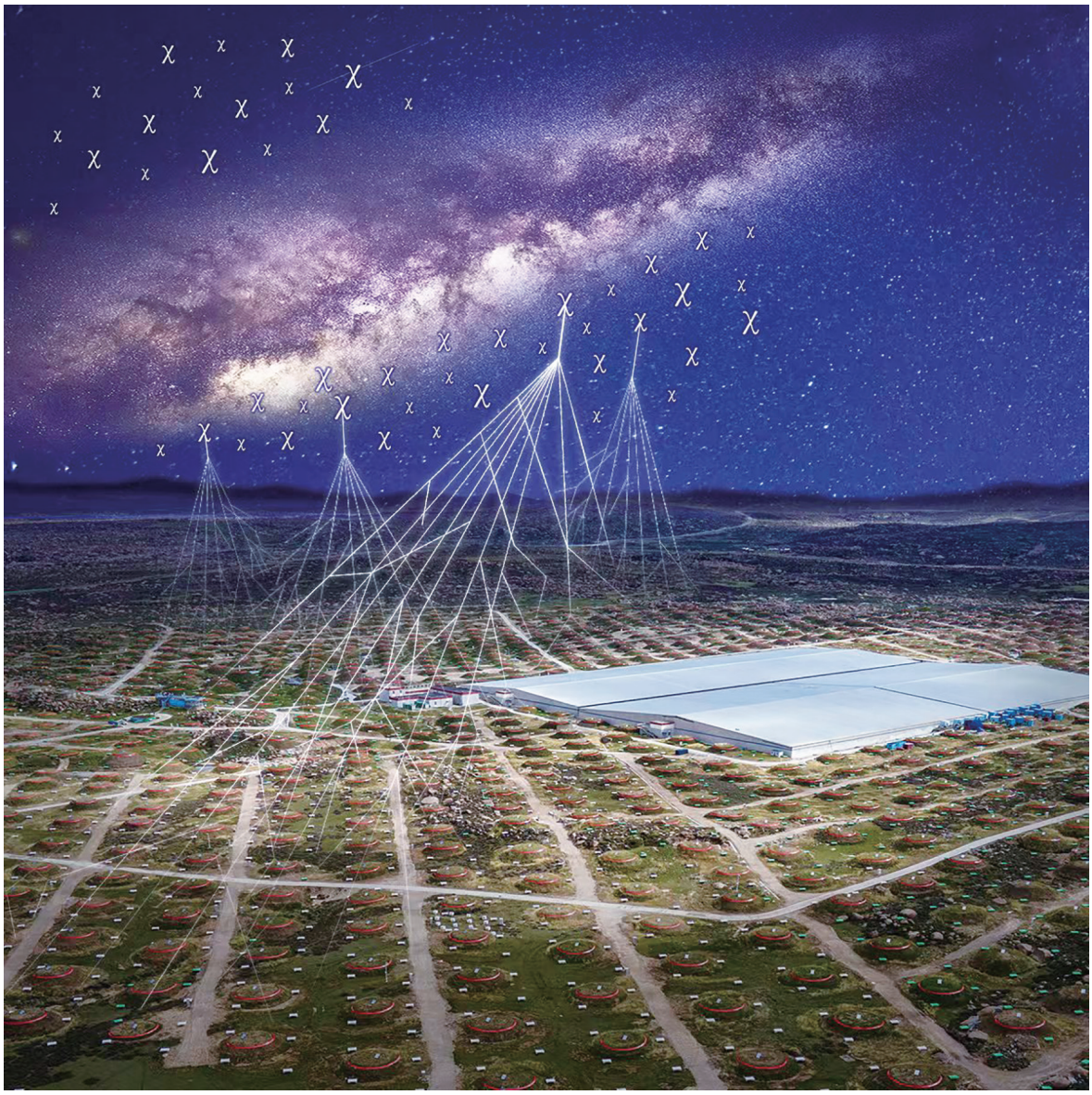
Thanks to its unprecedentedly high detection sensitivity to ultra-high-energy gamma rays (>100 TeV), LHAASO has the very unique potential to observe gamma rays decaying from heavy dark matter. LHAASO can eliminate background events by nearly six orders of magnitude above 100 TeV, hence significantly reduces background interference and improves the ability to capture gamma rays.

Using data from the Kilometer Square Array (KM2A), a subarray of LHAASO, scientists measured the intensity of ultra-high-energy gamma rays beyond the galactic plane and place some of the strongest constraints so far for the lifetime of heavy dark matter. Given no signs of access detected around the galactic plane compared with other regions, the research place constraint to the lifetime of this type of dark matter nearly 10 times higher than previously marked. This study shows that PeV mass dark matter has a lifetime of at least about billion trillion years (10^{21} years).

LHAASO's observations of gamma rays are highly



Shown are the 95% one-sided lower limits on DM lifetime obtained with the profile likelihood analysis (thick black lines), for DM decaying into b quarks (left) or τ leptons (right). (Image: LHAASO collaboration)



LHAASO-KM2A illustrated detecting gamma-rays from decaying heavy dark matter. (Image: LHAASO collaboration)

complementary to other experiments in the search of dark matter (such as neutrino observation experiments). As the LHAASO full array operates stably and gradually accumulates data, this constraint will be further explored.

This study was conducted by a joint team led by Profs. LI Zhe and CHEN Songzhan from the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences, Prof. Kenny C. Y. Ng from the Chinese University of Hong Kong, and Dr. Marco Chianese from the University of Naples Federico II in Italy.

(IHEP)