The impact of cosmic ray feedback on the Reionisation of the Universe

To understand how our present-day Universe came into being, we have to look back to a few hundred thousand years after the Big Bang, during the Epoch of Reionisation. This epoch, which marks the last major transition of the Universe from neutral to ionised, involves the formation of the first stars and galaxies and the radiation from those galaxies ionising the intergalactic medium. Thanks to numerical simulations, it is now established that supernova feedback can regulate both galaxy growth and the escape of ionising photons from galaxies. However, many recent works have suggested that other feedback mechanisms are also important in galaxies. In particular, cosmic rays have been shown to contribute to regulate star formation and to carry dense gas, which is where radiation is preferentially absorbed. As such, are they an important source of feedback in the early Universe, and do they play a role in the reionisation of the Universe by affecting the escape of ionising radiation from galaxies? To answer these questions, I would like to present the results from a suite of Sphinx simulations that include cosmic rays and radiation-magneto-hydrodynamics. These simulations are the first to date to model supernova, radiation and cosmic ray feedback in a cosmological context, both resolving thousands of galaxies and capturing the intergalactic medium. When cosmic ray feedback sufficiently regulates star formation at high-redshift, it also strongly delays the reionisation of the inter-galactic medium, by preventing ionising radiation to escape from the interstellar medium. Therefore, the process of reionisation could be sensitive to the efficiency of cosmic ray feedback, and could be used in turn as an additional constraint on our models of galaxy feedback.

Authors: Marion Farcy, Joakim Rosdahl, Jeremy Blaizot, Sergio Martin-Alvarez, Yohan Dubois