Dusty Giants: How galaxies form and destroy their dust in extreme environments?

Galaxies in the Universe are complex systems that consist of gas, stars, metals and dust. The nature of galaxies is not only affected by the interplay of these baryonic components, but they also share a strong relation with surrounding halos of invisible, dark matter, into which they are embedded. As galaxy progressively ages since it's formation, it passes through multiple evolutionary stages. Understanding physical mechanisms behind this evolution is one of the main goals of modern astronomy.

It has long been postulated that dust plays vital role in evolution of galaxies and their stars. It induces the formation of molecular clouds, supporting the birth of new stars. Dust grains also absorb stellar ultraviolet light at shorter wavelengths and re-emit it into in infrared, dramatically affecting the observed galaxy spectra. Major advances in far-infrared instrumentation in recent years, both space-based and ground-based, has led to the detection of more than a million, so-called dusty star-forming galaxies, very distant and massive objects that form large amount of dust and young stars. These discoveries posses a serious challenge to astronomy: many of these dusty 'Giants' have been formed when the Universe was very young, sometimes even less than 1 billion years after the Big Bang, and we wonder how could such large amount of stars and dust have been produced so early in time ?

Many theoretical models postulate that nature of dusty star-forming galaxies is key to understand formation of most massive structures in the Universe. The reason: these are thought to be direct evolutionary link between the most distant, active star-forming galaxies, and the most massive elliptical galaxies that reside in huge clusters we see in the local Universe. Probing and understanding this connection is a key task for modern infrared astronomy, but it is also highly challenging and under-investigated.

The project Dusty Giants aims at understanding the role of dust in galaxies and their large scale environments in galaxy evolution. The Project will pioneer the the methods to investigate the link between galaxy dark matter halos and life cycle of dust. This will be achieved by combining observations and state-of-the-art simulations in order to quantify how the relative ratio between dust and stars changes in different galaxy populations over cosmic time.

One of the expected outcomes will be a new technique of selecting and understanding distant proto-clusters. The Project is thus timely for providing the solid ground needed for interpreting future unprecedented data sets of large scale surveys of galaxies in the distant Universe (e.g. Euclid mission, Vera C. Rubin observatory) and their synergy with current millimetre telescopes on Earth (NIKA2, ALMA).