Research statement

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My research focuses on the understanding of supernova (SN) explosions, and in particular Type Ia SNe. I have worked in different steps of the chain necessary to obtain results in observational cosmology from SNe: instrumentation, taking data in a telescope, reducing and calibrating these data, programming code, and performing a detailed analysis of the data.

During the first year of my Ph.D. I had to perform CCD characterization studies of the devices Dark Energy Survey (DES) was going to use in DECam, its 520 Mpx camera. I helped to ensemble a laboratory set-up where the CCD devices were installed and tested. The aim of these tests was the optimization of the output CCD signal in order to satisfy DES science requirements. All these studies and the data analysis were compiled in my Master thesis., which was used by the Physics of the Accelerated Universe (PAU) project as a starting point for their CCD characterization.

As a collaborator member of SDSS-II Supernova Survey (SDSS-II/SNe), I participated in the obtention of 23 SN spectra during four nights in Fall 2007 using Telescopio Nazionale Galileo (TNG) located in La Palma. Once I had the data, I performed the reduction and calibration of these spectra using IRAF packages, and the determinations of the redshifts, in order to make them available to the whole collaboration.

One of these Type Ia SNe which we observed in La Palma (SN 2007qd) was a peculiar faint SN, one of the most subluminous event ever observed, which allowed us, in collaboration with Colin McClelland and Peter Garnavich (from U. Notre Dame, IN) and other people in SDSS-II/SNe, to write a paper about it. This SN possesses physical properties intermediate to those of the peculiar SN 2002cx and the extremely low-luminosity SN 2008ha, of what we could deduce that it might be a critical link between these two classes of objects. I had to use different analysis tools (SNID: spectra pattern recognition, SYNOW: synthetic spectra software generator, SNANA: SN light-curve fitter) in order to perform the analysis presented in the paper.

With all SDSS-II Type Ia SNe, I performed a study searching for dependencies between SN properties and the projected distance to the host galaxy center, using the distance as a proxy for local galaxy properties. I correlated the parameters given by the most common SNe light-curve fitters, MLCS (A_V, Δ) and SALT2 (x_1, c), and Hubble residuals, to both the physical and the normalized distances to the center of the host galaxy, accounting for different morphologies of the host when looking for correlations. We found that both A_V and c color parameters decrease with distance in spiral galaxies, and that SNe in elliptical galaxies tend to have narrower light-curves if they explode at larger distances. These two studies within SDSS-II/SNe were compiled in my Ph.D. thesis.

I am currently working on Integral Field Spectroscopy (IFS) of SN host galaxies at low redshift, as part of the CALIFA collaboration. Since we have spatially resolved spectra in the whole field of view ($\sim$1 arcmin^2), we can directly measure several galactic properties at different positions within the galaxy, including the position at which the SN exploded. I am preparing two different papers on the properties of the environment of Core-Collapsed and Type Ia SNe. I am also participating in several studies within the collaboration concerning the analysis of the spectra obtained from a fixed aperture at different redshifts, and the Mass-Metallicity (MZ) relation measured from local HII regions and its dependence on the Star Formation Rate (SFR). Finally, I am also preparing a new study within SDSS-II/SNe trying to correlate Type-Ia SN parameters with local characteristics of the host galaxies using spectra of the hosts from SDSS and radial gradients of these parameters.