Preface

The history of astronomy is as ancient as the reach of our written records. All the human civilizations have been interested in the study and interpretation of the night sky and its objects and phenomena. These observations were performed with the naked eye until the beginning of the seventeenth century, when Galileo Galilei started to use an instrument then developed called telescope. Since then, the range of accessible wavelengths has been increasing, with a burst in the twentieth century with the developing of instruments to observe them: antennas (radio and submillimeter), telescopes (optical, IR) and satellites (UV, X-rays and soft gamma rays). The last wavelength range accessed was the Very High Energy (VHE) gamma rays. At this range fluxes are so low that it is not possible to use space-based instruments with typical collection areas of $\mathcal{O}(1)$ m^2. We must resort to the imaging atmospheric Cherenkov technique, which is based on the detection of the flashes of Cherenkov light that VHE gamma rays produce when they interact with the Earth's atmosphere. The field is very young, with the first source discovered in 1989 by the pioneering Whipple telescope. It is very dynamic with more than 150 sources detected to date, most of them by MAGIC, HESS and VERITAS, that make up the current generation of instruments. Finally, the field is also very promising, with the preparation of a next generation of imaging atmospheric Cherenkov telescopes: CTA, that is expected to start full operation in 2020.

The work presented in this thesis comprises my efforts to take the ground-based γ-ray astronomy one step forward. Part I of the thesis is an introduction to the non-thermal universe and the imaging atmospheric Cherenkov technique. I also give on this part a very detailed description of the hardware, the data taking procedure and the data analysis of the Imaging Atmospheric Cherenkov Telescope (IACT) MAGIC. Finally, I give a glimpse to the future CTA.

Part II deals with several ways to reduce the trigger threshold of IACTs. This includes the simulation, characterization and test of an analog trigger especially designed to achieve the lowest possible energy threshold with the LSTs of CTA. Together with this work, the trigger of the MAGIC telescopes was improved. We have simulated, tested and commissioned a new concept of stereoscopic trigger.

This new system, that uses the information of the position of the showers on each of the MAGIC cameras, is dubbed “Topo-trigger”.

The scientific fraction of the thesis deals with galactic sources observed with the MAGIC telescopes. In Part III, I talk about the analysis of the VHE γ-ray emission of Pulsar Wind Nebulae (PWNe). I discovered VHE γ-ray emission from the puzzling PWN 3C 58, the likely remnant of the SN 1181 AD and the weakest PWN detected at VHE to date. I also performed population studies comparing several properties of the central pulsar such as age or spin-down power with the γ-ray luminosity of their surrounding PWNe. In this part, I also characterized the VHE tail of the Crab Nebula by observing it at the highest zenith angles, obtaining that the softening of the spectrum at multi-TeV energies is best represented by a log-parabola function. I also searched for an additional inverse Compton component during the Crab Nebula flares reported by *Fermi*-LAT in the synchrotron regime, not observing a significant enhance of the spectrum at TeV energies with respect to the one measured during non-flaring episodes.

Part IV is concerned with searches for VHE γ-ray emission of cataclysmic variable stars. I studied, on a multiwavelength context, the VHE γ-ray nature of the previously claimed pulsed γ-ray emission of the cataclysmic variable AE Aqr. The result of this search is that we could not confirm the previous claims of VHE γ-ray emission from this object. I also performed observations of novae and a dwarf nova to pinpoint the acceleration mechanisms taking place in this kind of objects and to discover a putative hadronic component of the soft γ-ray emission. With these observations, I obtained upper limits on the amount of accelerated hadrons on this type of objects.

The conclusion chapter summarizes all the work performed and lists prospects related with the topics treated in this thesis.

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