Título: STUDY OF VERY HIGH ENERGY GAMMA RAY SOURCES: DISCOVERY OF THE BLAZARS PKS 1222+21 AND 1ES 1215+303

Nombre: Becerra González, Josefa

Universidad: Universidad de La Laguna

Departamento: Astrofísica

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Dirección:

> **Director:** Ramón Jesús García López

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> **vocal:** Manel Martínez Rodríguez

> **vocal:** Elina Lindfors

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Resumen: Very High Energy (VHE, E>100 GeV) gamma-rays constitute still nowadays a largely unexplored observing window to the Universe. Due to the opacity of the Earth's atmosphere, the direct observation of these VHE gamma-photons is not possible from ground installations. Moreover, observation from Space by satellites results unfeasible for energies higher than 300 GeV due to the low fuxes and, therefore, the necessity of large collection area detectors which cannot yet be launched into Space. This problem can be circumvented by making use of the relatively new Cherenkov technique as indirect method for measuring the VHE gamm-rays from ground.

This work is devoted to the study of VHE gamma-ray sources from ground using the Imaging Atmospheric Cherenkov Telescopes (IACT) MAGIC. Since autumn 2009, the two MAGIC telecopes have been operated in stereoscopic mode, with a sensitivity two times better than the previous single telescope observations. A detailed analysis of a large sample of data taken in this mode is presented, in particular Active Galactic Nuclei (AGNs)

have been studied. The study of this type of sources in VHE gamma-rays is of crucial importance in order to understand the emission mechanisms in their jets since most of their energy is released in the VHE band. AGNs are also important for the study of the Extragalactic Background Light (EBL) which imprints its characteristics on the VHE spectrum of distant sources, distorting the VHE spectra due to the absorption of the gamma-photons by the interaction with the EBL photons leading to pair production of electrons and positrons. The study of the EBL has cosmological implications since it is composed of all redshifted emission from the different epochs of the Universe.

Only 46 AGNs have been detected up to now in the VHE range and the discovery of two of them is presented in this work. First, the discovery of the Flat Spectrum Radio Quasar (FSRQ) PKS 1222+21 close to the highest possible MeV/GeV are state is presented. This detection was performed contemporaneously with a measurement by the Fermi satellite, resulting in a differential energy spectrum which can be described by a simple power-law ranging from ~3 GeV up to 400 GeV. A cut-off can be excluded for energies lower than 130 GeV. This fact, together with the fast variability on a time scale of 10 minutes detected by MAGIC, heavily challenges the current emission models for FSRQs. In chapter 7, an improved emission model for this source is proposed, which consists of two emitting regions: one standard region modeled as a sphere whose diameter corresponds to the section of the jet, and a smaller and compacter region inside the jet travelling at different velocity than the rest of the surrounding jet matter.

Later, the first detection of the blazar 1ES 1215+303 in VHE gamma-rays is presented in chapter 8. A multi-frequency study of its variability has been carried out, showing that the emission from this object can be modeled using the standard Self-Synchrotron Compton model which typically is used to explain the emission from BL Lacs.
The last chapter of this thesis is devoted to a long-term study of the blazar 1ES 1218+304, which is found in the same FoV as 1ES 1215+303. For the first time, the detection of two sources in the same MAGIC FoV was possible, and a non-standard analysis had to be performed. 1ES 1218+304 has been detected in a steady state, compatible with previous observations.

For all these sources, the present generation of EBL models has been tested. Despite different approaches used in most of the models, all the tested currently accepted EBL models result compatible with the observations presented in this thesis.

In the appendix, a detailed explanation on how to analyze the stereoscopic MAGIC data can be found.