UAEU جامعة الإمارات العربيـة المتحدة United Arab Emirates University

The College of Graduate Studies and the College of Science Cordially Invite You to a

PhD Dissertation

Entitled

UNRAVELING THE ORIGINS OF GRB190114C: AN INVESTIGATION OF PROGENITOR MODELS THROUGH OBSERVATIONAL ANALYSIS

by

Nusrin Habeeb

Faculty Advisor

Dr. Aquib Moin, Associate Professor, Department of Physics

College of Science

Date & Venue

12 June 2023

2:00 pm

F3- Room 021

Abstract

Gamma-ray bursts (GRBs) are among the most energetic and violent events in the universe, characterized by sudden and intense emission of gamma rays lasting from a fraction of a second to several minutes. The primary focus of this thesis is to study gamma-ray bursts (GRBs), with a specific emphasis on GRB190114C. GRB190114C is a long-duration GRB that was detected on January 14, 2019, by the Fermi Gamma-ray Burst Monitor (GBM) and the Swift Burst Alert Telescope (BAT). It had a T90 duration of 116 seconds and a redshift of z=0.4245, which corresponds to a luminosity distance of about 2.9 billion light-years. The first part of this thesis presents the results of a 140-day observational campaign of the GRB190114C radio afterglow using the Australian Telescope Compact Array (ATCA). The study aimed to determine the dynamical and microphysical radio afterglow parameters and model the multifrequency radio data using variations of interstellar medium (ISM) and wind models. The obtained data allowed for the identification of the most plausible model that explains the evolution of the GRB190114C radio afterglow. Furthermore, the analysis helped to derive various microphysical parameters to better understand the properties and characteristics of this GRB. **The second part** of the work investigates the suitable progenitor model for GRB190114C. The widely accepted progenitor model for long-duration GRBs is the collapsar model, which involves a black hole-accretion disk (BHAD) system. In the context of the collapsar model, the BHAD system is formed from the remnants of the massive star's core that has collapsed into a black hole. Under the same model, there could be a possible binary system, where a helium core has a compact companion.Furthermore, the work discusses the two mechanisms that could cause these systems to produce highly energetic jets: neutrino annihilation and magnetohydrodynamics (MHD), which uses the Blandford-Znajek mechanism. These mechanisms were compared based on the observational results to further narrow down the plausibility of the progenitor models. To investigate the plausibility of these progenitor models, we derived prompt emission parameters such as isotropic energy E_iso and luminosity L_iso and used the multi-wavelength afterglow data from X-ray to radio to fit the light curves and spectral energy distribution, and derive the microphysical parameters. To further assess the likelihood of the proposed progenitor models, we compared these models and mechanisms based on the observational results obtained from the analysis of the afterglow data. Overall, this thesis contributes to a better understanding of the nature and properties of GRBs and their progenitor models. The detailed analysis of GRB190114C, including the modeling of its radio afterglow and investigation of its progenitor model, provides new insights into the most energetic phenomena in the universe. The findings of this study can inform future studies of similar events and improve our understanding of these fascinating phenomena.

Keywords: Radio Astronomy -- Gamma Ray Burst -- microphysical parameters -- Progenitors -- Collapsar Model -- Fireball Model -- Binary Black hole Model.