GRAVITATIONAL WAVES

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This is to certify that the thesis entitled **GRAVITATIONAL WAVES** is an authentic record of the research work carried out by **MR.AKHILRAJ U** in partial fulfillment of the requirements for the award of degree of Master of Science in Physics (2021–24) under the University of Calicut. The work presented in this thesis has not been submitted for any other degree or diploma earlier.

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Abstract

ASTRONOMY compels the soul to look upwards and lead us from this world to another. Because to understand who are we , what are we and why we here? In this universe all things are live in the blink of an eye .Then the question in where is the origin. Einstein's special theory of relativity revolutionized physics by teaching us that space and time are not separate entities but join as "space time". His general theory of relativity further taught us that space time is not just a stage on which dynamic takes place,but it is a participant. The field equation of general relativity connects matter dynamics to the curvature of spacetime.Curvature is responsible for gravity,carrying us beyond Newtonian conception of gravity that had been in place for the previous two and a half centuries. Much research in gravitation since then has explored and clarified the consequences of this revolution ; the notion of dynamical spacetime is now firmly estiablished that we may now contemplate using spacetime as a tool for other science. One aspect of dynamical spacetime -its radiative character, "gravitational radiation "–will inaugurate entirely new techniques for observing violent astrophysical processes. Over the next one hundred years , much of this subject's exicitement will come from learning how to exploit spacetime as a tool for astronomy.

Chapter 1

BASICS OF GRAVITATIONAL WAVES

The direct detection of gravitational waves (GWs) promises to usher in a new era of astronomy. The GW spectrum represents an entirely new window on the universe, independent of, and complimentary to, electromagnetic (EM) radiation. Gravitational waves can be used to directly probe objects unobservable by EM telescopes; e.g., the properties of black holes, the equation of state of neutron stars, and the state of the universe prior to the emission of the cosmic microwave background. Joint GW and EM observations offer more possibilities, such as understanding the progenitors of short-hard gamma-ray bursts (GRBs) and measuring the expansion of the universe. The GW spectrum would also give us insight into the physics of strong field gravity and numerical solutions of the Einstein equations, as well as provide a test for alternative theories of gravity [1]. The U.S. Laser Interferometer Gravitational-wave Observatory (LIGO) and the French-Italian Virgo interferometer are seeking to make the first direct detections of gravitational waves [2]. To date, LIGO has completed six Science runs. The first five of these runs were known as initial LIGO. In LIGO's fifth science run (S5), which lasted from November 2005 to September 2007, the LIGO detectors reached their design sensitivity, as they were sensitive to gravitational waves with strain amplitudes of 1021 in the 407000 Hz frequency band [2].LIGO's sixth science run (S6), also known as enhanced

LIGO [3], lasted from July 2009 until October 2010. Hardware improvements were make to the detectors for S6; during this period the LIGO detectors met and exceeded the sensitivity of S5. Virgo has had three science runs. Virgo's first science run (VSR1) overlapped with S5, lasting from May 2007 until October

1.1 what are gravitationl waves?

Gravitational waves are "ripples" in space time caused by some of the most violent and energetic processes in the Universe. Albert Einstein predicted the existence in his general theory of relativity . His mathematics show that the massive accelerating objects (Black holes or the nutron stars) would spacetime in such a way that 'waves' of undulating space time propagate in all the direction away from the source.These Ripples travel in speed of light in space, carry the information about their origin and clues to the nature of gravity itself.

1.2 The Newtionian gravity to Einstein

Newton's theory of gravity has enjoyed great success in describing many aspects of our every-day life and additionally explains most of the motions of celestial bodies in the Universe. He developed the set of equation that described the physical properties of the universe in exact manner. These equations were very successful in the classical world. In the time of 19th century ,people start noticing that not all plays according to this rule and this was the time of extensive study of the phenomena of electricity,magnetism and light. Maxwell published the st of equations that combined all these phenomena into a singke peice called "Electromagnetism". soon after Maxwell's discovery ,people realised that there is something wrong when its come to the equations.Their form changes when we move from one