



Search For Gravity Waves

Brian Clegg



Search For Gravity Waves:

Gravity's Shadow Harry Collins, 2004-09-04 According to the theory of relativity we are constantly bathed in gravitational radiation When stars explode or collide a portion of their mass becomes energy that disturbs the very fabric of the space time continuum like ripples in a pond But proving the existence of these waves has been difficult the cosmic shudders are so weak that only the most sensitive instruments can be expected to observe them directly Fifteen times during the last thirty years scientists have claimed to have detected gravitational waves but so far none of those claims have survived the scrutiny of the scientific community Gravity s Shadow chronicles the forty year effort to detect gravitational waves while exploring the meaning of scientific knowledge and the nature of expertise Gravitational wave detection involves recording the collisions explosions and trembling of stars and black holes by evaluating the smallest changes ever measured Because gravitational waves are so faint their detection will come not in an exuberant moment of discovery but through a chain of inference for forty years scientists have debated whether there is anything to detect and whether it has yet been detected Sociologist Harry Collins has been tracking the progress of this research since 1972 interviewing key scientists and delineating the social process of the science of gravitational waves Engagingly written and authoritatively comprehensive Gravity s Shadow explores the people institutions and government organizations involved in the detection of gravitational waves This sociological history will prove essential not only to sociologists and historians of science but to scientists themselves

The Search for Gravity Waves P. C. W. Davies, 1980-10-30 The search for and possible discovery of gravity waves for the non specialist reader No advanced knowledge of astronomy or mathematics is needed Ripples On A Cosmic Sea David G. Blair, Geoff Mcnamara, 1997 As the authors show the reward for this endeavor will be the opening up of an entirely new window on the universe

Gravity! Pierre Binétry, 2018-04-23 What force do the Big Bang the expansion of the Universe dark matter and dark energy black holes and gravitational waves all have in common This book uncovers gravity as a key to understanding these fascinating phenomena that have so captivated public interest in recent years Readers will discover the latest findings on how this familiar force in our everyday lives powers the most colossal changes in the Universe Written by the widely recognized French public scientist and leading astrophysicist Pierre Bin try the book also explains the recent experimental confirmation of the existence of gravitational waves

Ripples On A Cosmic Sea David Blair, Geoff Mcnamara, 1999-04-07 Most people live and work entirely oblivious to the fact that a myriad of ghostly ripples are passing through them all the time Generated in the depths of space by colliding stars and black holes exploding supernovas and quasars these so called gravitational waves are literally ripples in the fabric of space itself Sweeping across the cosmos at the speed of light they encode vital clues about the exotic systems that produced them Predicted by Einstein over eighty years ago but never detected in the laboratory gravitational waves have proven elusive to scientists In the first book for a general reader on these amazing waves Blair and McNamara weave a thrilling tale about the race to build the first

gravitational wave antenna a challenge that has prompted physicists and astronomers to devise some of the most breathtaking technology the world has ever seen What these scientists find will allow us to listen to the explosion of stars the creation of black holes even the sound of the Big Bang itself and will undoubtedly chart a new course for astronomy in the coming millennium

Gravitational Waves Brian Clegg, 2018-02-08 On 14 September 2015 after 50 years of searching gravitational waves were detected for the first time and astronomy changed for ever Until then investigation of the universe had depended on electromagnetic radiation visible light radio X rays and the rest But gravitational waves ripples in the fabric of space and time are unrelenting passing through barriers that stop light dead At the two 4 kilometre long LIGO observatories in the US scientists developed incredibly sensitive detectors capable of spotting a movement 100 times smaller than the nucleus of an atom In 2015 they spotted the ripples produced by two black holes spiralling into each other setting spacetime quivering This was the first time black holes had ever been directly detected and it promises far more for the future of astronomy Brian Clegg presents a compelling story of human technical endeavour and a new powerful path to understand the workings of the universe

Cosmic Search ,1980 Gravitational Waves Hartmut Grote, 2020 The historic detection of gravitational waves on September 14 2015 prompted by the highly energetic fusion of two black holes has made events in the universe audible for the first time This expansion of the scientific sensorium has opened a new chapter in astronomy and already led to among others fascinating new insights about the abundance of black holes the collision of neutron stars and the origin of heavy chemical elements The history of this event which is epochal for physics is reconstructed in this book along with a walk through of the main principles of how the detectors operate and a discussion of how the search for gravitational waves is conducted The book concludes with an update of the latest detections and developments to date and a brief look into the future of this exciting research field This book is accessible to non specialist readers from a general audience and is also an excellent introduction to the topic for undergraduates in physics Features Provides an introduction to the historic discovery of gravitational waves Explains the inner workings of the detectors and the search to find the waves hidden in the data Authored by a renowned specialist involved in the ground breaking discovery Hartmut Grote is a Professor of physics at Cardiff University UK His main expertise is in experimental gravitational wave physics and he has worked on building and improving gravitational wave detectors for over 20 years From 2009 to 2017 he was the scientific leader of the British German gravitational wave detector GEO600

Nuclear Science Abstracts ,1974

Advanced Interferometers and the Search for Gravitational Waves Massimo Bassan, 2014-07-08 The search for gravitational radiation with optical interferometers is gaining momentum worldwide Beside the VIRGO and GEO gravitational wave observatories in Europe and the two LIGOs in the United States which have operated successfully during the past decade further observatories are being completed KAGRA in Japan or planned ILIGO in India The sensitivity of the current observatories although spectacular has not allowed direct discovery of gravitational waves The advanced detectors Advanced

LIGO and Advanced Virgo at present in the development phase will improve sensitivity by a factor of 10 probing the universe up to 200 Mpc for signal from inspiraling binary compact stars This book covers all experimental aspects of the search for gravitational radiation with optical interferometers Every facet of the technological development underlying the evolution of advanced interferometers is thoroughly described from configuration to optics and coatings and from thermal compensation to suspensions and controls All key ingredients of an advanced detector are covered including the solutions implemented in first generation detectors their limitations and how to overcome them Each issue is addressed with special reference to the solution adopted for Advanced VIRGO but constant attention is also paid to other strategies in particular those chosen for Advanced LIGO

Overview Of Gravitational Waves, An: Theory, Sources And Detection Gerard Auger, Eric Plagnol, 2017-02-15 This book describes detection techniques used to search for and analyze gravitational waves GW It covers the whole domain of GW science starting from the theory and ending with the experimental techniques both present and future used to detect them The theoretical sections of the book address the theory of general relativity and of GW followed by the theory of GW detection The various sources of GW are described as well as the methods used to analyse them and to extract their physical parameters It includes an analysis of the consequences of GW observations in terms of astrophysics as well as a description of the different detectors that exist and that are planned for the future With the recent announcement of GW detection and the first results from LISA Pathfinder this book will allow non specialists to understand the present status of the field and the future of gravitational wave science

Pumpkopfdesign für den Advanced LIGO* Laser (*LIGO = Laser Interferometer Gravitational Wave Observatory) Oliver Puncken, 2011-12-13 Hohe Laserleistungen im Dauerstrichbetrieb bei gleichzeitig guter Strahlqualität kleinen Linienbreiten und geringem Leistungs- und Frequenzrauschen sind die Anforderungen an Lasersysteme die in Gravitationswellendetektoren eingesetzt werden sollen die nach dem Prinzip eines Michelson Interferometers arbeiten In der vorliegenden Arbeit werden Untersuchungen vorgestellt mit denen das Laserkonzept für den Gravitationswellendetektor LIGO Laser Interferometer Gravitational Wave Observatory weiter entwickelt wurde In seiner aktuellen Ausbaustufe soll das LIGO Lasersystem um einen injektionsgekoppelten Nd YAG Hochleistungsoszillator ergänzt werden mit dessen Hilfe die Laserleistung von 35 W auf 165 W skaliert werden soll Die Komplexität dieses Oszillators erlaubt nur bedingt eine genaue Untersuchung seiner Limitierungen in Ausgangsleistung und Strahlprofil Daher wurde das System für die in dieser Arbeit vorgestellten Experimente stark vereinfacht lässt aber trotzdem Rückschlüsse auf das LIGO Lasersystem zu Es wird ein asymmetrischer Stehwellenresonator verwendet der aus zwei sich gegenüber stehenden longitudinal gepumpten Nd YAG Kristallen besteht Zwischen den Kristallen befindet sich eine Doppelbrechungskompensation die aus einer 4f Abbildung und ein 90° Quarzrotator besteht Der Einfluss von Änderungen der Resonatorgeometrie der Pumplichtverteilung innerhalb des Lasermediums und des Lasermediums selbst auf das Laserverhalten werden separat betrachtet Das Konzept dynamisch stabiler Resonatoren erlaubt die Selektion der

transversalen Grundmode über die Wahl der optimalen ResonatorarmLängen Die Wahl wird von thermo optischen Effekten beeinflusst wie sie in dieser Arbeit mit Hilfe unterschiedlicher Methoden charakterisiert werden Durch die Pumplichtverteilung im Laserkristall kann das Anschwingen unterschiedlicher Moden kontrolliert und die Effizienz optimiert werden Bei einer sehr guten Strahlqualität des Pumplichtes können sich jedoch durch die Konzentration des Pumplichtes in der Nähe der Kristallachse thermo optische Effekte verstärken Es wird untersucht wie Effizienz Strahlqualität und Ausgangsleistung von der Pumplichtverteilung im Laserkristall abhängen Verschiedene Möglichkeiten Nd YAG Kristalle hinsichtlich ihrer Dotierung zu charakterisieren werden vorgestellt Mit dem Ziel einen Kristalltyp vorzuschlagen der möglichst effizient eingesetzt werden kann werden unterschiedliche Kristalldesigns untersucht Ausgangspunkt sind mit 0,1 at % dotierte Nd YAG Kristalle die für einen Pumplicht Doppeldurchgang ausgelegt sind Vergleichend werden Kristalle evaluiert die aus Segmenten unterschiedlicher Dotierung bestehen und damit niedrigere longitudinale Temperaturgradienten aufweisen Hier dotierte Kristalle die abseits des Nd YAG Absorptionsmaximums gepumpt werden bieten Vorteile hinsichtlich einer reproduzierbareren Kristallqualität Mit der Dotierung ändern sich jedoch die Pumplichtanteile die in Wärme Fluoreszenz und stimulierte Emission übergehen Dieser Zusammenhang wird in Rahmen der Arbeit analysiert Die Depolarisation linear polarisierter Laserstrahlung kann in gepumpten Nd YAG Kristallen die in 110 oder 100 Richtung geschnittenen sind reduziert werden Ein völliger Verzicht auf eine Doppelbrechungskompensation führt jedoch zu schlechteren Ergebnissen als die Verwendung von in der üblichen 111 Richtung geschnittenen Kristallen mit Doppelbrechungskompensation Die in dieser Arbeit durchgeführten Untersuchungen haben Einfluss auf die Entwicklung und das Verständnis des LIGO Oszillator genommen so dass in die amerikanischen Gravitationswellendetektoren ein ausgereiftes Lasersystem integriert werden konnte

Fundamentals Of Interferometric Gravitational Wave Detectors Peter R Saulson, 1994-10-26 Gravitational waves were predicted by Einstein over 75 years ago but have not yet been seen This book is about the technology of the new generation of interferometric gravitational wave detectors now being built such as the LIGO Laser Interferometric Gravitational Wave Observatory project in the US The book aims to make plain how these detectors function and why it is reasonable to think that gravitational waves may be successfully detected in the next decade After an introduction to the physical and astronomical aspects of gravitational waves the book concentrates on explaining the basic principles behind the detectors and discusses the strategies for utilising them All the required background in astronomy optics and experimental physics techniques is developed within the text and anyone with an undergraduate knowledge of physics will be able to follow the arguments presented The book will be of use not just to physicists and astronomers who wish to acquaint themselves with the subject but will also prove useful for courses in experimental physics at the advanced undergraduate and graduate levels

Relativistic Gravity Research Jürgen Ehlers, G. Schäfer, 1992-12-14 Proceedings of the 81 WE Heraeus Seminar Held at the Physikzentrum Bad Honnef Germany 2-6 September 1991

Traveling at the Speed of Thought Daniel Kennefick, 2007-04-15 Since Einstein first described them nearly a century ago gravitational waves have been the subject of more sustained controversy than perhaps any other phenomenon in physics These as yet undetected fluctuations in the shape of space time were first predicted by Einstein's general theory of relativity but only now at the dawn of the twenty first century are we on the brink of finally observing them Daniel Kennefick's landmark book takes readers through the theoretical controversies and thorny debates that raged around the subject of gravitational waves after the publication of Einstein's theory The previously untold story of how we arrived at a settled theory of gravitational waves includes a stellar cast from the front ranks of twentieth century physics including Richard Feynman Hermann Bondi John Wheeler Kip Thorne and Einstein himself who on two occasions avowed that gravitational waves do not exist changing his mind both times The book derives its title from a famously skeptical comment made by Arthur Stanley Eddington in 1922 namely that gravitational waves propagate at the speed of thought Kennefick uses the title metaphorically to contrast the individual brilliance of each of the physicists grappling with gravitational wave theory against the frustratingly slow progression of the field as a whole Accessibly written and impeccably researched this book sheds new light on the trials and conflicts that have led to the extraordinary position in which we find ourselves today poised to bring the story of gravitational waves full circle by directly confirming their existence for the very first time

Gravity's Ghost Harry Collins, 2010-12-15 A gripping look at gravitational wave research and what it says about scientific discovery and the future of the scientific community This fine book pairs exploratory analysis with the pulse of a detective story Giving a portrait of the way a community chose to test itself on the threshold of new knowledge Collins offers the rich sociological insight that can only be won from uncommon experience from a long standing dialogue with the community he studies and from a moral engagement in the future of science Richard Staley author of *Einstein's Generation The Origins of the Relativity Revolution* In theory at least gravitational waves do exist We are constantly bathed in gravitational radiation which is generated when stars explode or collide and a portion of their mass becomes energy that ripples out like a disturbance on the surface of a serene pond But unfortunately no gravitational wave has ever been directly detected even though the search has lasted more than forty years As the leading chronicler of the search for gravitational waves Harry Collins has been right there with the scientists since the start The result of his unprecedented access to the front lines of physical science is *Gravity's Ghost* a thrilling chronicle of high stakes research and cutting edge discovery Here Collins reveals that scientific discovery and nondiscovery can turn on scientific traditions and rivalries that ideal statistical analysis rests on impossible procedures and unattainable knowledge and that fact in one place is baseless assumption in another He also argues that sciences like gravitational wave detection in exemplifying how the intractable is to be handled can offer scientific leadership a moral beacon for the twenty first century In the end *Gravity's Ghost* shows that discoveries are the denouements of dramatic scientific mysteries A sociologist embedded with full access in the LIGO Scientific Collaboration chronicles the search for

gravitational waves Though physicists with very few exceptions are in no doubt that gravitational waves exist evidence for their passage through the new kilometer length interferometers would nevertheless represent the scientific event of the twenty first century Harry Collins has turned the initial joined search exploiting the LIGO and Virgo instruments into a detective novel that exquisitely describes the social processes associated with discovery and statistical analysis in a large collaborative effort Francis Halzen University of Wisconsin Madison and Director of Icecube Neutrino Detector Project

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