



# The Sun as a Guide to Stellar Physics



Edited by Oddbjørn Engvold, Jean-Claude Vial and Andrew Skumanich

# Solar And Stellar Physics

**C. de Jager, Zdenek Svestka**



## **Solar And Stellar Physics:**

**A Concise History of Solar and Stellar Physics** Jean-Louis Tassoul, Monique Tassoul, 2014-11-28 This book provides a comprehensive overview of the history of ideas about the sun and the stars from antiquity to modern times Two theoretical astrophysicists who have been active in the field since the early 1960s tell the story in fluent prose About half of the book covers most of the theoretical research done from 1940 to the close of the twentieth century a large body of work that has to date been little explored by historians The first chapter which outlines the period from about 3000 B C to 1700 A D shows that at every stage in history human beings have had a particular understanding of the sun and stars and that this has continually evolved over the centuries Next the authors systematically address the immense mass of observations astronomy accumulated from the early seventeenth century to the early twentieth The remaining four chapters examine the history of the field from the physicists perspective the emphasis being on theoretical work from the mid 1840s to the late 1990s from thermodynamics to quantum mechanics from nuclear physics and magnetohydrodynamics to the remarkable advances through to the late 1960s and finally to more recent theoretical work Intended mainly for students and teachers of astronomy this book will also be a useful reference for practicing astronomers and scientifically curious general readers *The Sun as a Guide to Stellar Physics* Oddbjørn Engvold, Jean-Claude Vial, Andrew Skumanich, 2018-11-15 The Sun as a Guide to Stellar Physics illustrates the significance of the Sun in understanding stars through an examination of the discoveries and insights gained from solar physics research Ranging from theories to modeling and from numerical simulations to instrumentation and data processing the book provides an overview of what we currently understand and how the Sun can be a model for gaining further knowledge about stellar physics Providing both updates on recent developments in solar physics and applications to stellar physics this book strengthens the solar stellar connection and summarizes what we know about the Sun for the stellar space and geophysics communities Applies observations theoretical understanding modeling capabilities and physical processes first revealed by the sun to the study of stellar physics Illustrates how studies of Proxima Solaris have led to progress in space science stellar physics and related fields Uses characteristics of solar phenomena as a guide for understanding the physics of stars **Solar and Stellar Physics** Egon-Horst Schröter, Manfred Schüssler, 1987 These proceedings bring together ideas from solar and stellar physics The sun is near enough for rather detailed observations and one chapter is devoted to the more recent experimental data from observations from space On the other hand the multitude of stars provides a wide range of physical parameters to test hypotheses in solar and stellar astrophysics The reader will find an illuminating overview of these fields ranging from the dynamo in the convection zone to the stellar envelopes and winds in the outer regions In particular the importance of small scale magnetohydrodynamic processes for the activity phenomena plays an important role in the contributions to this volume For both students and researchers the general introduction by N O Weiss makes an excellent guide to this very active field of research See also Lecture Notes in Physics Vol 291

**Synergies between Solar and Stellar Modelling** Maria Pia Di Mauro, Daniela Cardini, Marcella Marconi, 2010-11-17

This volume is a collection of articles originally published on a Special Issue of the *Astrophysics and Space Science Journal*. It is intended to give a comprehensive overview of the current state of knowledge in solar and stellar modelling with the aim of comparing and extending what we know from the detailed solar modelling made possible by the helioseismic tools and by the recent analysis of the solar spectrum to the modelling and understanding of generic stellar structures and their evolution. Particular emphasis is devoted to the role of the input physics and its relevant uncertainties in the construction of stellar models and in the resulting predictions for general observable quantities. Issues related to convection overshoot, diffusion and settling of helium and heavy elements, rotation, chemical composition and magnetic field are extensively discussed. Large space is dedicated to the application of helio and asteroseismic techniques as tools to probe the theory of the evolution and the structure of the stars. Comments on prospects for future improvements and refinements of the theoretical models are given focusing on the possibility of getting ever more precise helioseismic and asteroseismic observations from ground and space. The articles included in this volume are the results of the HELAS NA5 workshop *Synergies between solar and stellar modelling* held in Rome from 22nd to 26th of June 2009 which was a unique occasion to gather the solar and the stellar physics communities to discuss the urgent questions risen by recent photometric and spectroscopic observational results.

*Solar and Stellar Physics* Egon-Horst Schröter, Manfred Schüssler, 2014-03-12 These proceedings bring together ideas from solar and stellar physics. The sun is near enough for rather detailed observations and one chapter is devoted to the more recent experimental data from observations from space. On the other hand the multitude of stars provides a wide range of physical parameters to test hypotheses in solar and stellar astrophysics. The reader will find an illuminating overview of these fields ranging from the dynamo in the convection zone to the stellar envelopes and winds in the outer regions. In particular the importance of small scale magnetohydrodynamic processes for the activity phenomena plays an important role in the contributions to this volume. For both students and researchers the general introduction by N O Weiss makes an excellent guide to this very active field of research. See also *Lecture Notes in Physics* Vol 291

**Solar, Stellar and Galactic Connections between Particle Physics and Astrophysics** Alberto Carramiñana, Francisco Siddharta Guzmán

Murillo, Tonatiuh Matos, 2007-03-23 The very small and the very large are intimately connected in Nature. Particle physics and astrophysics meet in fundamental questions: the structure and evolution of stars, their end and how this is manifested, how we think galaxies are created from matter we have yet to discover and why we believe the most energetic particles cannot come from the most distant universe. During the IV Escuela Mexicana de Astrofísica EMA 2005 held in the beautiful colonial city of Morelia between 18 and 23 July 2005 we reviewed and explored the numerous connections between astrophysics and particle physics. The core of the school program aimed to advanced postgraduate students and young researchers in physics and astrophysics was formed by half a dozen extended lecture courses delivered by recognized experts in their fields.

The written versions of these courses became the main substance of this book. Three review talks were devoted to the techniques and results of novel astronomical windows of the XX and XXI centuries: radio astronomy, gamma ray astronomy and gravitational wave astronomy. This volume includes also six short contributions presented as single talks during the EMA 2005: examples of experimental and theoretical research work presently conducted in Mexico and Latin America. This book is the final product of a two year process centered on the EMA 2005. We believe it will serve as a guide not just to the participants but also to the communities of all interrelated fields.

Plasma Astrophysics Arnold O. Benz, 2002-06-30. This textbook is intended as an introduction to the physics of solar and stellar coronae, emphasizing kinetic plasma processes. It is addressed to observational astronomers, graduate students and advanced undergraduates without a background in plasma physics. Coronal physics is today a vast field with many different aims and goals. Singling out the really important aspects of an observed phenomenon and using the physics best suited for the case is a formidable problem. There are already several excellent books oriented toward the interests of astrophysicists that deal with the magnetohydrodynamics of stellar atmospheres, radiation transport and radiation theory. In kinetic processes the different particle velocities play an important role. This is the case when particle collisions can be neglected, for example in very brief phenomena such as one period of a high frequency wave or in effects produced by energetic particles with very long collision times. Some of the most persistent problems of solar physics like coronal heating, shock waves, flare energy release and particle acceleration are likely to be at least partially related to such processes. Study of the Sun is not regarded here as an end in itself but as the source of information for more general stellar applications. Our understanding of stellar processes relies heavily in turn on our understanding of solar processes. Thus an introduction to what is happening in hot dilute coronae necessarily starts with the plasma physics of our nearest star.

*Solar and Stellar Magnetic Fields: Origins and Coronal Effects* Jan Olof Stenflo, 1983-08-14. Traditionally solar and stellar physics have been two separate branches of astronomy which independently of each other have developed their own scientific goals and methods. During the last decade however we have witnessed a gradual convergence of these two areas. The solar physicists realize more and more that the sun has to be seen as a special case in a large family of stars of various properties. A more complete understanding of the sun can only be achieved by considering it in this broader context. The stellar physicists on the other hand have become aware that the detailed knowledge of the physical processes that the solar physicists have reached has a more general significance and can be applied to a variety of other astrophysical objects. Observational techniques developed in solar work can frequently be adapted for other stars as well. This unified approach to solar and stellar physics is often called the solar-stellar connection. One main goal of this approach has been to understand the general nature and causes of stellar activity. The pioneering and visionary program to search for activity cycles on other stars started by Olin Wilson at the Mount Wilson Observatory 16 years ago has borne fruit in his sample of 91 stars. Cyclic behaviour similar to that of the sun is found to be quite common but many stars also show irregular activity fluctuations of

large amplitude *Solar and Stellar Magnetic Fields: Origins and Coronal Effects* Jan Olof Stenflo, 1983-07-31 Traditionally solar and stellar physics have been two separate branches of astronomy which independently of each other have developed their own scientific goals and methods During the last decade however we have witnessed a gradual convergence of these two areas The solar physicists realize more and more that the sun has to be seen as a special case in a large family of stars of various properties A more complete understanding of the sun can only be achieved by considering it in this broader context The stellar physicists on the other hand have become aware that the detailed knowledge of the physical processes that the solar physicists have reached has a more general significance and can be applied to a variety of other astrophysical objects Observational techniques developed in solar work can frequently be adapted for other stars as well This unified approach to solar and stellar physics is often called the solar stellar connection One main goal of this approach has been to understand the general nature and causes of stellar activity The pioneering and visionary program to search for activity cycles on other stars started by Olin Wilson at the Mount Wilson Observatory 16 years ago has born fruit in his sample of 91 stars cyclic behaviour similar to that of the sun is found to be quite common but many stars also show irregular activity fluctuations of large amplitude

*Solar and Stellar Granulation* R. J. Rutten, Giuseppe Severino, 2012-12-06 Robert J Rutten Sterrekundig Instituut Utrecht The Netherlands Why this workshop Or rather since the real question that arose about a year ago was not whether there should be another OAC workshop but only what it should be about why a workshop on granulation To answer this question I will play an unfair trick on you I will simply present the scientific justification which I included last autumn in a grant application to NATO s Scientific Affairs Division It lists the reasons why I thought a workshop on this particular topic and at this particular moment ought to be worthwhile There must be something in its reasoning because NATO has indeed agreed to co sponsor this workshop and because all of you have decided to spend time and effort on your contributions and to journey to this beautiful island in order to participate But since the proof is in the pudding I am eager to see whether indeed this workshop will be as outstanding as I have promised in the meantime you are entitled to know what we got you here for The justification went as follows The subject granulation has recently become a hot topic at the center of much new research observational as well as interpretational and theoretical and both in solar physics and in stellar physics

*Solar Phenomena in Stars and Stellar Systems* R.M. Bonnet, A.K. Dupree, 2012-12-06 This book represents the proceedings of a NATO Advanced Study Institute which was held at Bonas from August 25 till September 5 1980 and was devoted to the study of Solar Phenomena in Stars and Stellar Systems It is intended for a broad audience Students and post doctoral scientists for example can discover new aspects of astrophysics The general spirit of the ASI was aimed at presenting a unified aspect of astrophysical phenomena which can be studied intensively on the Sun although they are of a much more general nature On the other hand specialists in solar or stellar physics will find here the latest theoretical developments and or the most recent observations made in their own field of research An extensive bibliography will be

found throughout the various sections to which the reader may refer for more detailed developments in various specific areas. In the past stellar and solar astrophysics have more or less followed their own independent tracks. However, with the rapid development of modern techniques in particular artificial satellites like the International Ultraviolet Explorer and the Einstein Observatory which provide a new wealth of data, it appears that chromospheres, coronae, magnetic fields, mass loss and stellar winds etc. are found not only in the Sun but occur also in other stars. Frequently these other stars represent quite different conditions of gravity, luminosity and other parameters from those occurring in the Sun.

*Solar and Stellar Flares*  
Lyndsay Fletcher, Petr Heinzel, 2016-12-21. This volume is a collection of research articles on the subject of solar flares and flares on other cool stars which are currently extensively studied using new ground and space based instruments together with highly sophisticated numerical simulations. The collection memorializes the work of a pioneer in the study of solar physics Professor Zdenek Vestka 1925-2013. Bunschoten, a leading expert in the field of solar flares and the co-founder and Editor in Chief of the journal *Solar Physics*. The book contains many contributions to the conference *Solar and Stellar Flares: Observations, Simulations and Synergies* held in Prague during 23-27 June 2014, organised in honor and memory of Professor Vestka. Originally published as Topical Issue of *Solar Physics* Vol 290 Issue 12 2015.

**Plasma Astrophysics**  
Arnold O. Benz, 2011-09-30. This textbook is intended as an introduction to the physics of solar and stellar coronae, emphasizing kinetic plasma processes. It is addressed to observational astronomers, graduate students and advanced undergraduates without a background in plasma physics. Coronal physics is today a vast field with many different aims and goals. Sorting out the really important aspects of an observed phenomenon and using the physics best suited for the case is a formidable problem. There are already several excellent books oriented toward the interests of astrophysicists that deal with the magnetohydrodynamics of stellar atmospheres, radiation transport and radiation theory. In kinetic processes the different particle velocities play an important role. This is the case when particle collisions can be neglected, for example in very brief phenomena such as one period of a high frequency wave or in effects produced by energetic particles with very long collision times. Some of the most persistent problems of solar physics like coronal heating, shock waves, flare energy release and particle acceleration are likely to be at least partially related to such processes. Study of the Sun is not regarded here as an end in itself but as the source of information for more general stellar applications. Our understanding of stellar processes relies heavily in turn on our understanding of solar processes. Thus an introduction to what is happening in hot dilute coronae necessarily starts with the plasma physics of our nearest star.

*Progress in Solar Physics* C. de Jager, Zdenek Svestka, 2012-12-06.  
*Solar and Stellar Physics Through Eclipses* Osman Demircan, Selim O. Selam, Berahitdin Albayrak, 2007.

**Dynamics of the Sun and Stars** Mário J. P. F. G. Monteiro, Rafael A. García, Jørgen Christensen-Dalsgaard, Scott W. McIntosh, 2020-12-18. These are the proceedings of a meeting celebrating Michael Thompson's seminal work on solar and stellar physics as well as his major contributions to the development of the National Center for

Atmospheric Research The meeting also marked Michael J Thompson's untimely death in October 2018 Michael played a key role in the development of helioseismology and its application to the study of the structure and dynamics of the solar interior and he provided a strong foundation for the extension of seismic studies for other stars After focusing for several years on more administrative activities he was returning to leading the seismic studies of solar interior rotation and he was deeply involved in the understanding of the dynamics of the core of stars when his life was tragically lost The conference focused on dynamical aspects of the sun and stars based on the large amount of data available on solar and stellar oscillations and the extensive and detailed modelling now becoming feasible Combining observations seismic analysis and modelling the meeting and this book serve as a fitting memorial to a close colleague and friend much missed

**Problems of Solar and Stellar Oscillations** D.O. Gough, 2012-12-06 D O GOUGH Institute of Astronomy Madingley Road Cambridge U K IAU Colloquium 66 on Problems of Solar and Stellar Oscillations was held at the Crimean Astrophysical Observatory U S S R on 15 September 1981 The principal purpose of the colloquium was to study the low amplitude oscillations of the Sun and to a lesser extent to consider similar oscillations of other stars Much of the emphasis of the discussions was on the diagnostic value of the oscillations In the last few years we have become aware that the frequencies of the five minute modes of high degree which constitute the major component of the oscillations discovered twenty years ago by Evans and Michaud can be used to put quite tight bounds on the stratification of the solar convection zone These permit a calibration of solar models computed from so called standard evolution theory Modes of low degree penetrate beneath the convection zone to the core of the Sun and can in principle test the evolution theory Therefore there was considerable interest in the reports of the latest observations of such modes Broadly speaking those observations confirm the calibration by the high degree modes but there remain some systematic discrepancies that demand some revision of the theory Besides the gross aspects of evolution theory there are also more intricate details to be understood

**Solar and Stellar Magnetic Fields: Origins and Coronal Effects** Jan Olof Stenflo, 1983-07-31 Traditionally solar and stellar physics have been two separate branches of astronomy which independently of each other have developed their own scientific goals and methods During the last decade however we have witnessed a gradual convergence of these two areas The solar physicists realize more and more that the sun has to be seen as a special case in a large family of stars of various properties A more complete understanding of the sun can only be achieved by considering it in this broader context The stellar physicists on the other hand have become aware that the detailed knowledge of the physical processes that the solar physicists have reached has a more general significance and can be applied to a variety of other astrophysical objects Observational techniques developed in solar work can frequently be adapted for other stars as well This unified approach to solar and stellar physics is often called the solar stellar connection One main goal of this approach has been to understand the general nature and causes of stellar activity The pioneering and visionary program to search for activity cycles on other stars started by Olin Wilson at the Mount Wilson Observatory 16

years ago has born fruit in his sample of 91 stars cyclic behaviour similar to that of the sun is found to be quite common but many stars also show irregular activity fluctuations of large amplitude

**The Sun as a Variable Star: Solar and Stellar Irradiance Variations** Judit M. Pap, Claus Fröhlich, Hugh S. Hudson, W. Kent Tobiska, 2012-12-06 The IAU Colloquium No 143 The Sun as a Variable Star Solar and Stellar Irradiance Variations was held on June 20 25 1993 at the Clarion Harvest House Boulder Colorado USA The main objective of this Colloquium was to review the most recent results on the observations theoretical interpretations and empirical and physical models of the variations observed in solar and stellar irradiances A special emphasis of the Colloquium was to discuss the results gained on the climatic impact of solar irradiance variability The study of changes in solar and stellar irradiances has been of high interest for a long time Determining the absolute value of the luminosity of stars with different ages is a crucial question for the theory of stellar evolution and energy production of stellar interiors Observations of the temporal changes of solar and stellar irradiances in the entire spectral band and at different wavelengths provide an additional tool for studying the physical processes below the photosphere and in the solar stellar atmospheres Since the Sun's radiative output is the main driver of the physical processes with in the Earth's atmosphere the study of irradiance changes is an extremely important issue for climatic studies as well Climatic models show that small but persistent changes in solar irradiance may influence the Earth's climate

**Solar and Stellar Magnetic Activity** C. J. Schrijver, C. Zwaan, 2008-10-30 This timely volume provides the first comprehensive review and synthesis of current understanding of magnetic fields in the Sun and similar stars Magnetic activity results in a wealth of phenomena including starspots non radiatively heated outer atmospheres activity cycles deceleration of rotation rates and even in close binaries stellar cannibalism all of which are covered clearly and authoritatively This book brings together for the first time recent results in solar studies and stellar studies The result is an illuminating new view of stellar magnetic activity Key topics include radiative transfer convective simulations dynamo theory outer atmospheric heating stellar winds and angular momentum loss Researchers are provided with a state of the art review of this exciting field and the pedagogical style and introductory material make the book an ideal and welcome introduction for graduate students

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