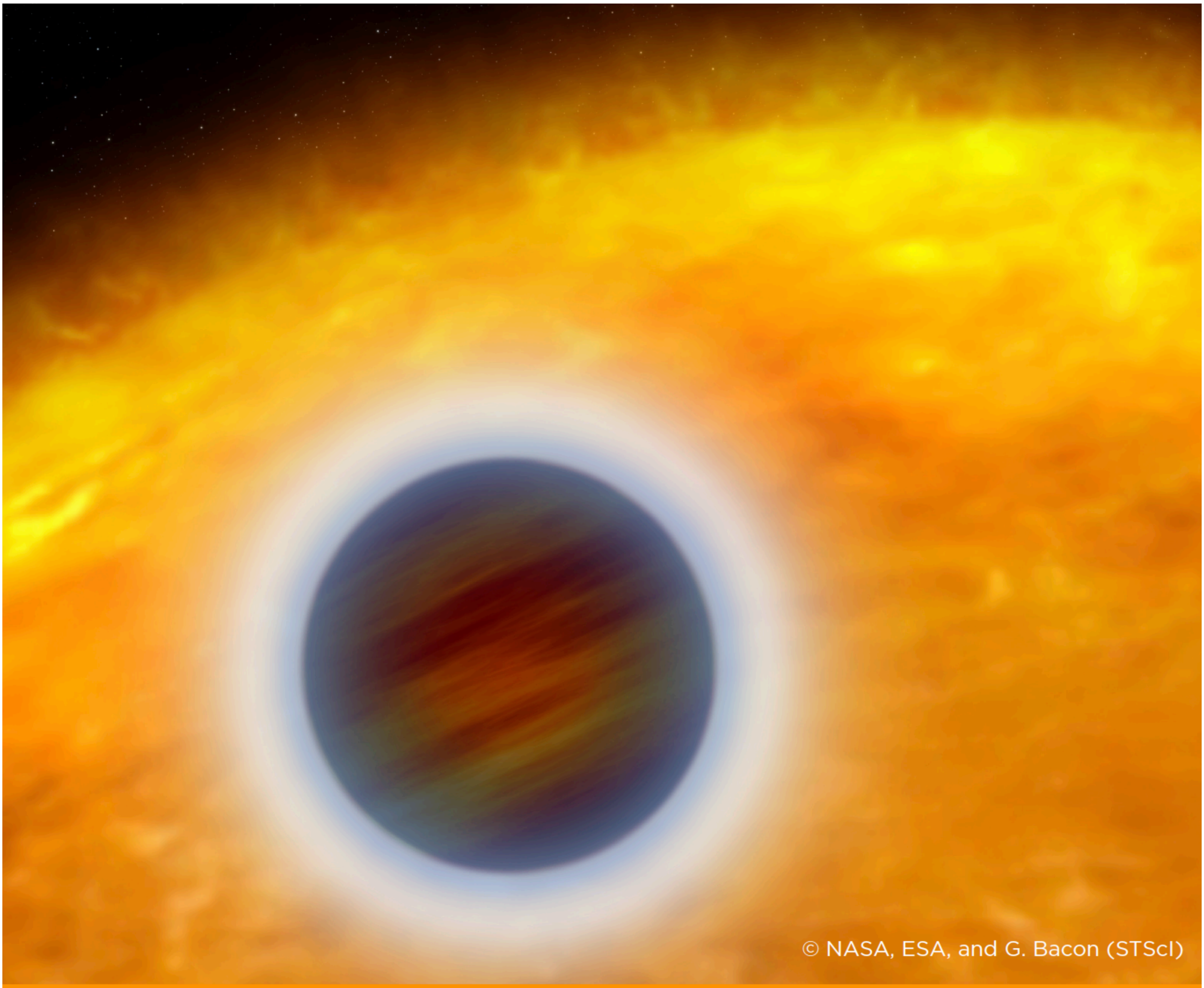

Radiative signatures from the cosmos

A conference in honor of Ivan Hubeny

October 23-26, 2018

Book of Abstracts

Local Organizing Committee (LOC):

Salvatore Colombo
Xavier Fresquet
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Dominique Lopes
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Scientific Organizing Committee (SOC):

Katia Cunha
Thierry Lanz (Chair)
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Chantal Stehlé
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Short presentation of the Conference

Radiation as a messenger from the cosmos

Most of the information from the cosmos travels as electromagnetic radiation. Light, however, is perturbed by the medium in which it propagates before reaching ground- or space-based telescopes. Radiative transfer deals with this interaction between light and matter. The most direct signatures of these interactions come from spectroscopy. Radiative transfer thus leaves an impact on spectra and images taken from astronomical objects. Besides the spectra observed remotely, the structure of these objects itself is also directly affected through radiative absorption and emission.

The meeting on radiative signatures from the cosmos

The meeting is devoted to state-of-the-art modern tools used to diagnose the properties of emitting astrophysical objects and to predict their structure. We will thus focus on the topology, composition, dynamics, distance, morphology of different cosmic objects, from extrasolar planets up to Active Galactic Nuclei, and the information provided by radiation.

Topics

1- Fundamental radiative transfer and modeling techniques
2- Exoplanet atmospheres
3- Cool stars & brown dwarfs
4- Hot stars & degenerate stars
5- Binaries
6- Supernovae
7- Stellar population synthesis
8- Accretion disks

Agenda

Tuesday 23, October 2018

8:30	Registration	
9:00	Welcome address	
9:10	The challenges of observing, calibrating, and modeling stellar spectral energy distributions	Carlos Allende Prieto
9:40	Solar flare simulations with RHD codes Flarix and RADYN	Jana Kasparova
10:05	Transformative Advances in our Knowledge of Accretion Physics of Accreting White Dwarfs in Explosive Interacting Binaries	Edward Sion
10:30	Coffee Break	
11:00	Spectroscopy of multiple stellar systems	Petr Hadrava
11:25	Atomic diffusion and radiative accelerations in stellar atmospheres	Georges Alecian
11:50	Tracing physical processes affecting spectral formation in the low luminosity B[e] stars of the FS CMa group	Daniela Korcakova
12:15	Lunch break	
14:15	Breaking the rules: classical novae as testbeds for extending spectral modeling	Steve Shore
14:50	Spectral analysis of the binary nucleus of the planetary nebula Hen 2-428	Nicolle Finch
15:15	Gould's Belt and Beyond	Jan Palous
15:40	Posters Session & Coffee	
16:30	3D NLTE Monte Carlo radiative transfer code based on macroatom approach	Jakub Fisak
16:55	3D Spectral Radiative Transfer and perspectives for spectroscopic diagnostics	Laurent Ibgui
18:15	**Cocktail at Observatoire de Paris**	

Wednesday 24, October 2018

9:00	Modeling the Complex Spectra of Supernovae	John Hillier
9:35	Heavy-Metal Abundances in DO-type White Dwarfs	Thomas Rauch
10:00	Coffee Break	
10:30	New tool for atmospheric parameters determination and abundance analysis of hot stars	Tomasz Rozanski
10:55	Polarized line formation in spherically symmetric expanding atmospheres	Sampoorna Malali
11:20	Massive parallel spectroscopy: A stellar census of galactic globular clusters	Stefan Dreizler
11:45	Lunch Break	
13:50	Stellar Population Synthesis	Claus Leitherer
14:25	Insight on the sources of cosmic reionisation and their stellar and ISM properties	Daniel Schaerer
14:50	The Brightest Stars in the Universe as Extragalactic Probes of Cosmic Abundances and Distances	Rolf-Peter Kudritzki
15:25	Coffee Break	
16:00	Young, Massive Stars and Black Holes in the Low-Metallicity Galaxy, I Zw 18	Sara Heap
16:35	Radiative transfer in an expanding universe	Benoit Semelin
17:10	A Simplified Analytic Treatment of Partial Redistribution in Resonance Lines	Kenneth Gayley
17:35	Self-consistent multilevel PRD	Véronique Bommier

Thursday 25, October 2018

9:00	From stars to planets: the importance of radiative transfer	Tristan Guillot
9:35	Radiation feedback in accretion shocks on Young Stars	Lionel de Sa
10:00	Coffee Break	
10:30	Examining magnetospheric accretion in Herbig Ae/Be stars through near-infrared spectroscopic signatures	Markus Schoeller
10:55	Inclusion of inhomogeneities in static NLTE model atmospheres	Jiri Kubat
11:20	The importance of white dwarfs in astrophysics	Martin Barstow
11:55	Neutron star model atmospheres	Klaus Werner
12:20	Lunch break	
14:20	Polarized line scattering theory with applications in astrophysical radiative transfer: a historical perspective	Kanakatte Nagendra
14:55	Golden times of partial redistribution	Petr Heinzel
15:30	Coffee Break	
16:00	NLTE line blanketing	Thierry Lanz
16:35	Black holes beyond astrophysics	Veronika Hubeny
17:10	Radiative Transfer in Astrophysical Bodies: Yesterday, Today, and Tomorrow	Ivan Hubeny
17:45	Posters Session	
20:00	**Social dinner - on the River Seine**	

Friday 26, October 2018

9:00	Exoplanetary Atmospheres	Nikku Madhusudhan
9:35	New Avenues in Atmospheric Modelling of Exoplanets	Siddharth Gandhi
10:00	Coffee Break	
10:30	A description of the SHELLSPEC program	Jan Budaj
10:55	Task-based Radiative Transfer Methods in the DISPATCH Code Framework	Ake Nordlund
11:30	Spectral Models of Accreting Black Holes from Radiation Magnetohydrodynamic Simulations	Shane Davis
12:05	The method of transfer functions to describe GR effects in spectra and polarisation from black-hole accretion disks	Vladimir Karas
12:30	Conclusions	

Blue = Keynote speaker

Posters list

1. Non conservative Rayleigh scattering. A perturbative approach, *H. Frisch*
2. Early B-type stars with resolved Zeeman split lines, *S. Hubrig*
3. Radiation effects on impact of accretion streams in Classical T - Tauri Stars, *S. Colombo*
4. Methods to solve multi-dimensional polarized radiative transfer equation with line scattering, magnetic fields and partial frequency redistribution, *A. Lokanathapura Seetharamabhasari*
5. A spectroscopic and kinematical analysis of the hottest white dwarfs from the SDSS DR14, *N. Reindl*
6. Effects of angle-dependent partial frequency redistribution on polarized line profiles, *S. Malali*
7. Polarized line formation with Paschen-Back effect and partial frequency redistribution, *S. Malali*
8. The Quasi-WR stars HD 45166 and WR 7a revisited, *B. Doležalová*
9. Spectroscopic features of an evolved hot chemically peculiar star: HR 62 (B8 III), *T. Kılıçoğlu*
10. Atmospheric parameters and chemical abundances of pulsating Beta Cephei stars in open clusters, *E. Niemczura*
11. MontAGN - A 3D Radiative Transfer Code for the Modelling of Active Galactic Nuclei and Super Star Clusters, *T. Nguyen*
12. A new near-IR C2 linelist for improved chemical analysis of hydrogen deficient carbon-rich giants, *D. Garcia-Hernandez*
13. Astroserver Live - Online spectral analysis with Tlusty models, *P. Nemeth*
14. 3D Monte Carlo Radiative Transfer in inhomogeneous massive star winds : application to resonance line formation, *B. Kubátová*
15. maKe Atoms Simple (KAS): a tool for create, manipulate and build model atoms, *Y. Osorio*
16. Thermally driven disk winds in X-ray binaries - radiation-hydrodynamic simulations, *N. Higginbottom*
17. Python - a Monte Carlo radiative transfer and ionization code, *N. Higginbottom*
18. Radial abundance gradients of OB stars in the outer Galactic disk, *S. Daflon*
19. *Formation of strong emission lines in stellar accretion disks: the link between observations and models, B. Tessore*

Abstracts
(alphabetical order)

Atomic diffusion and radiative accelerations in stellar atmospheres

Georges Alecian*[1]

[1]CNRS, Observatoire de Paris, PSL Research University, Université Paris Diderot – CNRS, Observatoire de Paris – France

Abstract

Atomic diffusion modifies elements distribution in the atmospheres of the main-sequence chemically peculiar A and B type stars. The main ingredient in evaluating diffusion effects in atmospheres is the radiative acceleration, which accounts for the momentum transfer from the photon flux to atoms. In most cases these stars have strong magnetic fields, which make radiation transfer calculations very heavy to achieve. I will present recent works in this subject, and will present the numerical tools (from calculation of polarized radiation transfer to time-dependent elements stratification) that are developed to describe the surface of these stars.

*Speaker

The importance of white dwarfs in astrophysics

Martin Barstow*[1]

[1]Department of Physics and Astronomy [Leicester] – University of Leicester, University Road, Leicester, LE1 7RH, United Kingdom

Abstract

All stars with masses below, approximately, 8 times that of the Sun will become white dwarfs. Therefore, these objects are ubiquitous in the Galaxy. Their long cooling times allow limits to be placed on the age of the galactic disk and the white dwarf luminosity function can reveal the history of star formation. White dwarfs are also implicated in the production of type 1a supernovae. More recently, they have been found to accreting debris from extra-solar planetary systems and could be potential probes of variations of fundamental physical constants in strong gravitation fields. However, studying all these phenomena requires accurate measurements of the physical properties (temperatures, masses and radii) of sample of individual stars, which themselves rely on the availability of realistic stellar atmosphere models. This oral presentation will review our understanding of the properties of white dwarfs and the important role played by stellar model atmosphere calculations in this work.

*Speaker

sciencesconf.org:radcosmos:220236

Self-consistent multilevel PRD

Véronique Bommier*[1]

[1]Laboratoire d'études spatiales et d'instrumentation en astrophysique – Observatoire de Paris, CNRS : UMR8109, Université PSL – France

Abstract

The atomic density matrix formalism has enabled the self-consistent derivation of both polarised radiative transfer and statistical equilibrium of the multilevel atom (Bommier, 2016, A&A, 591, A59). This derivation sums up the perturbation series of the matter-radiation interaction, in the weak radiation field limit. This formalism is convenient for modelling the polarised profiles of stellar atmosphere spectral lines, in the general case of partial redistribution (PRD). This new formalism will be presented, together with a numerical application developed for the case of the solar Na I D line doublet observed close to the solar limb, taking into account fine and hyperfine structure and interferences and off-diagonal coherences, together with Rayleigh and Raman scattering.

*Speaker

sciencesconf.org:radcosmos:218027

A description of the SHELLSPEC program.

Jan Budaj*[1]

[1]Astronomical Institute of the Slovak Academy of Sciences – Slovakia

Abstract

Program SHELLSPEC is designed to calculate light curves, spectra and images of interacting binaries and extra-solar planets immersed in a moving gaseous or dusty circumstellar matter (CM). It solves simple radiative transfer along the line of sight in 3D moving media. The Roche model and synthetic spectra from the stellar atmosphere models such as TLUSTY from Ivan Hubeny can be used as a boundary condition for the radiative transfer. The scattered light from the two stars can be taken into account assuming that CM is optically thin. The assumptions include LTE and optional known state quantities and velocity fields in 3D. These can be taken from the 3D hydrodynamic simulations.

Alternatively, optional (non)transparent objects such as: a central star, companion star, envelope, spot, stream, ring, disc, nebula, flow, jet, ufo, or a shell may be defined in 3D and their composite synthetic spectrum calculated. The stars may have either the Roche or spherical geometry, optional velocity or rotation, and may have spots. They are subject to the gravity darkening, limb darkening, and irradiation effect including the heating,reflection and day-night heat redistribution.

Synthetic light curves or trailing spectrograms can be produced bychanging your view points on the 3D object.

A few examples with applications to spectroscopy, Doppler tomography, photometry, and interferometry of binary stars and transiting exoplanets will be presented.

*Speaker

sciencesconf.org:radcosmos:205750

Radiation effects on impact of accretion streams in Classical T Tauri Stars

Salvatore Colombo*[1,2,3], Laurent Ibgui[2], Salvatore Orlando[1], Rafael Rodriguez[4], Matthias González[5], Chantal Stehle[2], and Lionel De Sá[2]

[1]INAF - Osservatorio Astronomico di Palermo, Italy

[2]LERMA (Laboratory for Studies of Radiation and Matter in Astrophysics and Atmospheres), Paris Observatory, Sorbonne University, École Normale Supérieure (ENS), Cergy-Pontoise University, CNRS, France

[3]Università di Palermo, Italy

[4]Universidad de Las Palmas de Gran Canaria, Spain

[5]Paris Diderot University, AIM, CEA, CNRS, France

Abstract

Classical T Tauri Stars (CTTSs) are young stars accreting mass from their circumstellar disks. According to the largely accepted magnetospheric accretion scenario, the disk extends up to the truncation radius. In this region, the magnetic field is strong enough to disrupt the inner part of the disk and to channel the material towards the star forming accretion columns. The channeled material impacts into the stellar surface producing shocks that heats up the plasma at a few million degrees.

In the last twenty years, the X-ray and UV observations of these systems have raised several questions. In particular, the UV lines arising from the accretion regions show complex profiles, which cannot be easily interpreted using current accretion models. Also, the observed X-ray luminosity is systematically below the value predicted by theoretical models.

To tackle these problems, we modelled the structure and the dynamics of the plasma in the impact region using radiation hydrodynamics simulations, including, for the first time, the effects of radiative transport in the Non-Local Thermodynamic Equilibrium (NLTE) regime.

The radiation arising from the shocked plasma is partially absorbed by the unshocked accretion column. As a result, due to the absorption of X-rays arising from the shocked plasma at the impact region, the pre-shock downfalling accreted material is gradually heated up to a few 10^5 K.

We discuss the implication of this pre-shock heating for the UV and X-ray emission arising from the impact region.

*Speaker

sciencesconf.org:radcosmos:220179

Radial abundance gradients of OB stars in the outer Galactic disk

Simone Daflon[1], Gustavo Braganca[1], Thierry Lanz*[2], Katia Cunha*[1,3], Ivan Hubeny*[3], Thomas Bensby[4], Paul Mcmillan[4], Catherine Garmany[5], John Glaspey[5], Marcelo Borges Fernandes[1], and Sally Oey[6]

[1]Observatório Nacional – Brazil
[2]Observatoire de Cote d'Azur – Observatoire de la Cote d'Azur – France
[3]Steward Observatory, University of Arizona – United States
[4]Lund Observatory – Sweden
[5]NOAO – United States
[6]University of Michigan – United States

Abstract

Metallicity gradients are important constraints for models of chemical evolution. We present the present-day radial gradients oxygen and silicon abundances in the Galactic disk using a sample of main-sequence O- and B-type stars with galactocentric distances between 8.4 and 15.6 kpc. Our analysis is based on the fits of non-NLTE synthetic profiles computed with TLUSTY and SYNSPEC to high-resolution echelle spectra obtained with the MIKE spectrograph at Magellan Telescope, Las Campanas. We obtained stellar parameters, silicon and oxygen abundances from the Non-LTE synthesis, and estimated stellar distances based on GAIA DR2 results. We present the radial distributions of oxygen and silicon abundances and discuss the obtained gradients in terms of models of galactic evolution.

*Speaker

Spectral Models of Accreting Black Holes from Radiation Magnetohydrodynamic Simulations

Shane W. Davis*[1]

[1]University of Virginia – United States

Abstract

Detailed comparisons between observational spectra and standard disk models suggest that black hole X-ray binaries are well modelled by accretion disks, but a number of problems arise when the models are applied to AGN observations. I will briefly review the observational and theoretical considerations that might explain these discrepancies. These considerations strongly motivate radiation magnetohydrodynamic simulations, which are increasingly utilized to study accreting black hole systems. I will report on some of the surprising results from recent simulations and the spectral predictions that they make.

*Speaker

sciencesconf.org:radcosmos:225416

Accretion shocks on Young Stars: recent results and perspectives

Lionel De Sá*[1,2], Chantal Stehlé[1], Jean-Pierre Chièze[2,1], Ivan Hubeny[3], Thierry Lanz[4], Salvatore Colombo[1,5,6], Laurent Ibgui[1], and Salvatore Orlando[6]

[1]LERMA (Laboratory for Studies of Radiation and Matter in Astrophysics and Atmospheres), Paris Observatory, Sorbonne University, École Normale Supérieure (ENS), Cergy-Pontoise University, CNRS, France

[2]Astrophysique Interactions Multi-Echelles, UMR7158, CEA, CNRS, Paris Diderot University, France

[3]Steward Observatory, University of Arizona, Tucson, AZ, USA

[4]Côte d'Azur Observatory, Nice, France

[5]Università di Palermo, Italy

[6]INAF - Osservatorio Astronomico di Palermo, Italy

Abstract

One of the first stages in pre-main sequence stars' evolution is mainly governed by exchanges of mass and momentum between the proto-star and its accretion disk. These quantities remain uncertain due to numerous unanswered questions concerning the topology of the accretion flow, its temperature, its observability in the UV and X-ray bands, its (a)periodic behavior, if and how accretion affects the coronal activity of the proto-star, etc.

In this talk, I will focus on 1D simulations of accretion columns falling onto a dynamically heated stellar chromosphere. I will present the method used for the radiative hydrodynamics. I will specifically focus then on the creation of dedicated opacity tables, using SYNSPEC code. With this method, we studied two phenomena: first, the mutual feedback between a dynamically heated chromosphere and the accretion process, then the coupling between radiation and matter. I will finally present our perspectives on this topic.

These studies have been funded by the French "Programme National de Physique Stellaire" of INSU, the French Italian cooperation program PICS 6838 "Physics of Mass Accretion Processes in Young Stellar Objects", the Observatoire de Paris and the LABEX PLAS@PAR (ANR-11-IDEX-0004-02)

*Speaker

The Quasi-WR stars HD 45166 and WR 7a revisited

Barbora Doležalová*[1,2] et al.*

[1]Ústav teoretické fyziky a astrofyziky PřF MU, Brno – Czech Republic
[2]Astronomický ústav, Akademie věd České republiky, Ondřejov – Czech Republic

Abstract

We studied NLTE winds of quasi Wolf-Rayet (qWR) stars. This group consist of only two stars HD 45166 and WR 7a. HD 45166 was classified as such, but WR 7a is only suspected to be qWR star and it is not typical Wolf-Rayet star anymore. New research shows that there is a link between hot subdwarfs and Wolf-Rayet stars and this link are stars like HD 45166. We compared the wind models of both stars (HD 45166 and WR 7a) and the findings were compared with the research that has already been done.

*Speaker

Massive parallel spectroscopy: A stellar census of galactic globular clusters

Stefan Dreizler*[1], Sebastian Kammann[2], Tim-Oliver Husser[3], Benjamin Giesers[3], Fabian Göttgens[3], Marylin Latour[3], Merten Dahlkemper , Leon Von Holt[3], and Muse Consortium And

[1]Georg-August-University [Göttingen] – Germany

[2]Astrophysics Research Institute, Liverpool John Moores University – United Kingdom

[3]Institute für Astrophysik, Georg-August-Universität Göttingen – Germany

Abstract

Our knowledge of Galactic globular clusters (GCs) has progressed significantly in the previous years. The availability of adequate data has given us unique insights into their chemical composition as well as their dynamics. A true paradigm shift has been the discovery that GCs consist of multiple stellar populations. The discovery has triggered an ongoing discussion about the formation of GCs as none of the models invoked so far to explain the existence of multiple populations can explain the wealth of existing data. Further insight may come from studies of the cluster dynamics, i.e. the rotation properties (Kamann et al. 2018) as well as binary fraction as well as possible intermediate mass or stellar black holes (Giesers et al. 2018).
Our ongoing observations with MUSE at the VLT using its unique capabilities allowed us to acquire more than 1 000 000 spectra for more than 200 000 stars in 25 GCs. We make use of our source extraction code designed to extract spectra from 3D data cubes in crowded stellar fields. We then use our extensive grid of model atmospheres for a full spectrum analysis. We use these data to investigate the spectroscopic and kinematic properties of GCs and their multiple populations. A status report of the project is presented at the conference.

*Speaker

sciencesconf.org:radcosmos:223911

Spectral analysis of the binary nucleus of the planetary nebula Hen 2-428

Nicolle Finch*[1], Nicole Reindl[1], Martin Barstow[2], Sarah Casewell[1], Stephan Geier[3,4], Veronika Schaffenroth[4], Marcelo Miller-Bertolami[5,6], and Stefan Taubenberger[3]

[1]University of Leicester – United Kingdom

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[3]European Southern Observatory (ESO) – Karl-Schwarzchild Str. 2 D-85748 Garching bei Munchen, Germany

[4]University of Potsdam – Germany

[5]Instituto de Astrofisica de La Plata, UNLP-CONICET, La Plata – Argentina

[6]Facultad de Ciencias Astronomicas y Geofisicas, UNLP, La Plata, – Argentina

Abstract

Binary systems provide us with an excellent laboratory for studying stellar evolution. In particular, systems with two evolved stars are rare and intriguing, as they have to undergo multiple mass transfer events to form. As well as this, double degenerate systems with short enough orbits and high enough system masses are candidates for type Ia supernovae, via the proposed double degenerate merger channel. There are _˜100 double white dwarf binaries with orbital periods less than 1 day, as well as _˜50 known white dwarf-hot sub dwarf binaries; however, there are only a few double hot sub dwarf systems. Of these double degenerates, only a handful are of sufficient mass to be considered type Ia candidate systems. We provide the first quantitative spectroscopic analysis of the binary central stars of the planetary nebula Hen 2-428, whose spectra are similar to that of hot sub dwarfs. The mass of these central stars is still open to debate; Santander-Garcia et al. (2015) conclude masses totalling greater than the Chandrasekhar Limit, making it a candidate type Ia progenitor system. However, Garcia-Berro et al. (2016) find a lower mass solution that fits the observations as well. We attempt to resolve this debate by using synthetic spectra from state-of-the-art non-LTE models to constrain the radial velocities, and thus calculate dynamical masses. Our synthetic spectra also provide us with the atmospheric parameters of the central stars. Based on these results, we discuss the implications of the supernova Ia progenitor status of Hen 2-428.

*Speaker

sciencesconf.org:radcosmos:219384

3D NLTE Monte Carlo radiative transfer code based on macroatom approach

Jakub Fisak*[1] et al.

[1]Masaryk University, Faculty of Science – Czech Republic

Abstract

We will present our 3D Monte Carlo Radiative Transfer code for the stellar wind. The code is based on the Lucy macro atom approach which includes photons (Thomson scattering, line absorption, free-free absorption, ionization), internal atomic energy (radiative deexcitation, internal downward or upward jump to other states, collisional deexcitation, radiative recombination, collisional recombination), and kinetic energy (colllisional excitation, collisional ionization, free-free and free bound transitions). This code calculates emergent spectrum of an input stellar wind model (calculated by, e.g., some hydrodynamic code). The code is being developed to solve the NLTE line formation problem.

*Speaker

sciencesconf.org:radcosmos:220420

Non conservative Rayleigh scattering. A perturbative approach

Helene Frisch*[1]

[1]Laboratoire Lagrange – Centre National de la Recherche Scientifique - CNRS – France

Abstract

The continuous spectrum of stellar and planetary atmospheres may be linearly polarized by Rayleigh or Thomson scattering. If the scattering process is the only source of continuous absorption, the scattering is conservative since all the absorbed photons are reemitted, and the polarization can be described by the Chandrasekhar's law. If true absorptions, due to e.g. bound-free transitions, are also contributing to the continuous absorption coefficient, the scattering becomes non conservative and the polarization decreases.

It will be shown that deviations from the Chandrasekhar's law due to true absorptions can be derived from a perturbation analysis of the polarized radiation field, using as expansion parameter the ratio k c/(k c + s c), with k c and s c the true and scattering absorption coefficients. The perturbation analysis is based on the introduction of an optical depth, rescaled by the thermalization length, and on the description of the radiation field as the sum of an interior field depending only on the rescaled optical depth and a boundary layer contribution going to zero in the interior.

The predictions of the perturbation analysis will be compared to numerical solutions of the full radiative transfer equation for a range of values of the expansion parameter between 10(-10) and 10(-2).

*Speaker

sciencesconf.org:radcosmos:223125

New Avenues in Atmospheric Modelling of Exoplanets

Siddharth Gandhi* and Nikku Madhusudhan[1]

[1]University of Cambridge (CAM) – United Kingdom

Abstract

We are entering the era of high-precision and high-resolution spectroscopy of exoplanets. Such observations require robust self-consistent spectral models of exoplanetary atmospheres to investigate intricate atmospheric processes and to make observable predictions. Thus there is a growing need for a new generation of models custom-built for exoplanets over a wide planetary parameter space that incorporate state-of-the-art numerical methods, opacities and conditions not seen in the solar system. We discuss a new self-consistent atmospheric modelling code, GENESIS, which models radiative-convective and chemical equilibrium atmospheres of exoplanets. We also highlight some new developments and challenges in the modelling of such planets. We investigate models of irradiated and non-irradiated planets over a range of C/O ratios and metallicities to determine the spectra and P-T profiles of such objects. In light of new high quality datasets, we introduce a new paradigm of exoplanetary remote sensing whereby a self-consistent equilibrium model is coupled with an inverse atmospheric retrieval code to allow constraints on disequilibrium processes. We use such an approach to constrain radiative-convective as well as chemical disequilibria in hot Jupiters using thermal emission spectra. We highlight the importance of both advanced numerical methods and techniques as well as the application to observations to understand the processes that occur in exoplanetary atmospheres.

*Speaker

sciencesconf.org:radcosmos:220367

A new near-IR C2 linelist for improved chemical analysis of hydrogen deficient carbon-rich giants

Domingo Aníbal García-Hernández*[1], Thomas Masseron[1], Olga Zamora[1], Arturo Manchado[1], N. Kameswara Rao[2], Arumalla Reddy[3], David Lambert[3], Sergey Yurchenko[4], and Jonathan Tennyson[4]

[1]Instituto de Astrofísica de Canarias (IAC) – Spain

[2]Indian Institute of Astrophysics – India

[3]McDonald Observatory – United States

[4]University College of London [London] – United Kingdom

Abstract

Diatomic carbon (C2) is ubiquitous in astronomical environments, from comets and stars to translucent clouds and the interstellar medium. In particular, the C2 bands (mainly the Ballik-Ramsay and Phillips transitions) are an important source of opacity in the near-IR region of carbon stars such as the hydrogen deficient carbon-rich (HdC) or R Coronae Borealis (RCB) stars. Present C2 linelists are still not accurate enough (e.g., in wavelength positions) to model the near-IR spectra of HdC and RCB stars, strongly limiting our ability to properly model their complex spectra and to extract the elemental (an isotopic, when possible) abundances of key elements like C, N, O, F, etc. We have generated a new near-IR C2 linelist (both Ballik-Ramsay and Phillips systems) with the PGopher code, using the Chen et al. (2015) molecular constants to compute line positions and the DUO code to compute line intensities. The synthetic spectrum constructed for the benchmark HdC star HD 137613, using this new C2 linelist, provides an unprecedented match to its high-resolution (R_˜50,000) observed spectrum. The new C2 linelist is thus expected to significantly improve the near-IR chemical analysis for HdC and RCB stars but also for normal carbon stars (e.g., C-rich AGB and dwarf stars) and even Solar System bodies like comets.

*Speaker

sciencesconf.org:radcosmos:222793

A Simplified Analytic Treatment of Partial Redistribution in Resonance Lines

Kenneth Gayley*[1]

[1]University of Iowa – United States

Abstract

Ivan Hubeny contributed to the conceptual understanding of partial redistribution in strong resonance lines, elaborating on his concept of "frequency thermalization." These types of concepts can be developed into semi-analytic expressions that approximate and complement formal analytic treatments, allowing a range of tradeoffs between simplicity and accuracy in the modeling of strongly coherent resonance lines. This talk focuses on the conceptual advances made possible by "rough and ready" analytic approximations to resonance-line transfer, with an eye to better understanding the nature of such transfer as a precursor to more accurate modeling, and as a means of guiding more rapid convergence of detailed simulations. To this end, the conceptual value of second-order transfer treatments, a partially coherent version of the Eddington-Barbier relation, and the comoving-frame partially coherent scattering approximation, are unified into simple, albeit approximate, results.

*Speaker

sciencesconf.org:radcosmos:223271

From stars to planets: the importance of radiative transfer

Tristan Guillot*[1]

[1]Laboratoire Lagrange – Université de Nice-Sophia Antipolis, Observatoire de la Cote d'Azur (OCA) – France

Abstract

Radiative transfer is governing the structure and evolution of stars and planets. I will present grey and semi-grey analytical solutions for irradiated atmospheres and will discuss how they inform us on the evolution and compositions of exoplanets. I will then show that the growth of the inner radiative region in the pre-MS phase of stellar evolution is key to the estimation of the impact of planet formation on stellar composition.

*Speaker

sciencesconf.org:radcosmos:225531

Spectroscopy of multiple stellar systems

Petr Hadrava*[1]

[1]Astronomical Institute of the Czech Academy of Sciences – Czech Republic

Abstract

Observations of binary and multiple stellar systems enable us to find the basic parameters like masses and radii of the component stars. Spectroscopy can yield additional parameters of stellar atmospheres like the temperatures, chemical composition etc., however, its interpretation is complicated firstly due to the blending of component spectra and - compared to single stars - also by the more complex physics in which the mutual interaction of the component stars may play a significant role. Some of these problems and the ways to their solution will be briefly summarized in this contribution.

*Speaker

sciencesconf.org:radcosmos:227553

Young, Massive Stars and Black Holes in the Low-Metallicity Galaxy, I Zw 18

Sara R. Heap*[1], Jean-Claude Bouret[2], Ivan Hubeny[3], and Thierry Lanz[4]

[1]Emerita Scientist, NASA/GSFC – Greenbelt - United States
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Abstract

I Zw 18 is a local star-forming dwarf galaxy having a very low metal content, O/H ˜1/50 solar. While galaxies with such low metallicity are rare in the low-redshift universe, they are likely to be common in galaxies at cosmic dawn. Thus, the spectrum of I Zw 18 is a "living" template for z> 6 galaxies. The goal now is to build theoretical models that reproduce its observed spectrum. Such models can then be used as starting points to explore the physical conditions in which stars and black holes form and evolve in an extremely low-metallicity environment.

We have obtained HST/COS far-UV spectra of the massive northwest star cluster in I Zw 18 and have compared them to SYNSPEC model spectra by Lanz & Hubeny (2003, 2007) in order to determine the properties of the stellar population and to understand its feedback in the form of photoionization and stellar winds. We have also compared the observed spectra of I Zw 18-NW to the CLOUDSPEC models of Hubeny, Heap, and Lanz (2000) of the stellar population with an embedded ultra luminous X-ray source (ULX) in order to estimate the feedback of the stellar black hole in the form of photoionization and heating.

*Speaker

sciencesconf.org:radcosmos:225015

Golden times of partial redistribution

Petr Heinzel*[1]

[1]Astronomical Institute, Czech Academy of Sciences – Czech Republic

Abstract

Although rather isolated and without any e-mail (of course at those times), with Ivan we were highly motivated to contribute to radiative-transfer theory. This was at the end of seventies and during eighties when we devoted a significant effort to further develop the theory of scattering in spectral lines with partial redistributions. Also abroad, and namely in the US, this topic was very up-to-date at those golden times, just mentioning D. Mihalas, D. Hummer, J. Cooper and several others. I will review those developments and mention also subsequent significant contributions of Ivan to this field.

*Speaker

sciencesconf.org:radcosmos:222925

Python - a Monte Carlo radiative transfer and ionization code

Nick Higginbottom*[1]

[1]University of Southampton – United Kingdom

Abstract

Python is a multi-purpose, Monte-Carlo radiative transfer and ionization code which has been developed to compute spectra from a wide range of astrophysical objects from cataclysmic variables to quasars. It is able to use a range of analytic wind models and also read in arbitrary gas distributions from hydrodynamic simulations. Populations of photons are generated from user defined radiating objects including accretion disks and stars and transported through the wind. Their effect on the temperature and ionization state of the gas is calculated in a set of ionization cycles. Once the temperature is converged, the transmitted and diffuse spectra are generated for a restricted range of frequencies and viewing angles. We incorporate the macro-atom formulation of Lucy, but also include simpler ionization modes for faster execution where the physical conditions are suitable. Here we present our code and highlight recent successes in modelling different systems including the investigation of broad absorption lines in AGN, thermal wind driving in X-ray binaries and the production of synthetic reverberation maps in AGN.

*Speaker

Thermally driven disk winds in X-ray binaries - radiation-hydrodynamic simulations.

Nick Higginbottom*[1]

[1]University of Southampton – United Kingdom

Abstract

Essentially all low-mass X-ray binaries (LMXBs) in the soft state appear to drive powerful equatorial disc winds. A simple mechanism for driving such outflows involves X-ray heating of the top of the disc atmosphere to high temperatures. At large radii, the thermal speed exceeds the escape velocity, and mass loss is inevitable. Here, we present the first coupled radiation-hydrodynamic simulation of such thermally-driven disc winds. Initially, we have adopted parameters representative of the wind-driving LMXB GRO_~J1655-40 and our model yields a mass-loss rate that is more than twice the accretion rate. This agrees well with the mass-loss rate inferred from Chandra/HETG observations of the source at a time when the system had a similar luminosity to that adopted in our simulations. We also present synthetic line profiles for hydrogen and helium like Iron, which show similar line equivalent widths to the observations, although the outflow velocities are much lower than inferred from observations. We then increase the luminosity towards the Eddington rate, and note that the wind efficiency (wind mass-loss rate/accretion rate) tends to a constant value, although the velocity of the outflow increases with increasing source luminosity.

*Speaker

Modeling the Complex Spectra of Supernovae

Desmond Hillier*[1]

[1]Department of Physics and Astronomy Pittsburgh Particle Physics, Astrophysics, and Cosmology Center (PITT PACC), University of Pittsburgh – United States

Abstract

We describe the difficulties in modeling the spectra and light curves of supernovae (SNe), and highlight how they differ from modeling stellar atmospheres. Supernovae evolve in time, and hence time-dependent radiation transfer is necessary. The densities are low, making non-LTE calculations absolutely essential, and at some epochs it is also necessary to include time-dependence in the kinetic equations. The abundances are non-solar and vary throughout the SN ejecta. Species often considered to be unimportant (e.g., cobalt, titanium) can be abundant and can have a crucial influence on spectra. Further, hydrogen and helium are often underabundant (or even absent), substantially reducing the continuum opacity. In Type Ia SNe, bound-bound processes dominate spectra formation and thermalization. Unfortunately, accurate atomic data for many ionization stages and species is lacking. The transport of gamma-rays arising from radioactive decay also needs to considered. These gamma-rays deposit energy, and give rise to non-thermal electrons which can both ionize and excite the gas. In some cases the SN interacts with an existing CSM, converting much of their kinetic energy to electromagnetic energy. Due to complex time-dependent dynamics, shock formation and non-monotonic velocities, spectra arising from such interactions are difficult to model. In reality, SNe are likely to be aspherical, necessitating 3D calculations. Other researchers have made significant progress towards 3D models of SNe using Monte-Carlo techniques.

*Speaker

sciencesconf.org:radcosmos:224093

Radiative Transfer in Astrophysical Bodies: Yesterday, Today, and Tomorrow

Ivan Hubeny*[1]

[1]Steward Observatory, University of Arizona – United States

Abstract

I will first discuss some highlights of astrophysical treatment of radiation transport achieved in the past several decades, with emphasis on improved physical understanding, as well as on numerical and computational aspects of the problem.
I will then briefly summarize the present status of modeling stellar and planetary atmospheres, and of treatment of radiative transfer in astrophysics in general.
Finally, I will outline several general topics that I think will be pursued in the near future, such as 3-D radiation hydrodynamic description of atmospheres and disks, and complex non-equilibrium models, including dynamics, chemistry, and radiation, of exoplanet atmospheres.

*Speaker

sciencesconf.org:radcosmos:225510

Black holes beyond astrophysics

Veronika Hubeny*[1]

[1]University of California , Davis – United States

Abstract

Aside from being fascinating (and in many ways extreme) objects in astrophysics, black holes have played an increasingly prominent role in theoretical physics: they underlie "holographic dualities" (originally formulated within the framework of string theory), through which they can be related to more mundane non-gravitational systems. Rather tantalizingly, they also hint at profound connections to quantum information theoretic constructs, in particular entanglement. In this overview-style talk I will try to give a broad-brush picture of the multifaceted nature of black holes.

*Speaker

sciencesconf.org:radcosmos:222794

Early B-type stars with resolved Zeeman split lines

Swetlana Hubrig*[1] and Et Al.

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Abstract

Almost three decades ago, Mathys (1990) demonstrated the importance of studying Ap stars showing resolved Zeeman split Fe II 6147.7 and 6149.2 lines. Such Zeeman split lines can only be seen in stars whose projected rotational velocity is sufficiently small and whose magnetic field is strong enough to exceed the rotational Doppler broadening. Observations of resolved Zeeman split lines permit the diagnosis of the average of the modulus of the magnetic field over the visible stellar hemisphere, which allows us to set additional constraints on the field geometry. Furthermore, studies of radial gradients of magnetic fields in stellar atmospheres using magnetically split components lying on different sides of the Balmer jump are important to detect changes of the atmospheric structure in the presence of a magnetic field. Although Zeeman splitting is not expected in hot massive stars where rotation is not the only broadening mechanism shaping the line-profiles, we have recently been discovering three early B-type displaying magnetically split spectral lines. For these stars, we will discuss the Zeeman splitting of several spectral lines and present measurements of the mean magnetic field modulus.

*Speaker

sciencesconf.org:radcosmos:221382

3D Spectral Radiative Transfer and perspectives for spectroscopic diagnostics

Laurent Ibgui*[1], Ivan Hubeny[2], Thierry Lanz[3], Matthias González[4], Chantal Stehlé[1], Salvatore Colombo[1,5,6], and Salvatore Orlando[6]

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Abstract

As 3D (radiation) magnetohydrodynamic models (RMHD) are starting to emerge in various domains of theoretical astrophysics, – e.g., accretion columns and jets in young stellar objects, protoplanetary discs, stellar and planetary atmospheres – it is becoming important to be able to test these 3D models by comparing their predicted spectroscopic signatures with observations.

To this end, the three-dimensional spectral radiative transfer code IRIS has been specifically designed to post process RMHD 3D simulations, in order to provide emissivity maps and synthetic spectra. I will describe the numerical features that are currently implemented in this code that is still under development. I will detail the first applications of IRIS, which was used to post-process laboratory radiating shocks 3D RHD simulations performed with the HERACLES code. IRIS could assess the validity of the approximate model M1 used for the treatment of radiation coupled with hydrodynamics. It could also evaluate the spatial, angular, and spectral distribution of the radiation that emerges from the radiating shock.

I will finally summarize the future prospects considered for IRIS, in particular the characterization of spectral signatures of accreting flows onto young stellar objects.

*Speaker

sciencesconf.org:radcosmos:220189

The method of transfer functions to describe GR effects in spectra and polarisation from black-hole accretion disks

Vladimir Karas*[1]

[1]Astronomical Institute, Czech Academy of Sciences – Czech Republic

Abstract

We will review a fruitful way to compute variety of radiation signatures from accretion disks in strong gravity. Five transfer functions can be pre-computed and then employed to generate model spectra and to fit them to data in X-rays. We have been developing this approach to analyse spectra and light curves in the corona-disk-line geometry, and to anticipate the polarimetric properties of this scenario with upcoming missions IXPE and eXTP.

*Speaker

sciencesconf.org:radcosmos:223128

Solar flare simulations with RHD codes Flarix and RADYN

Jana Kasparova*[1], Mats Carlsson[2], Petr Heinzel[1], and Michal Varady[3,1]

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[2]Institute of Theoretical Astrophysics, University of Oslo – Norway
[3]Jan Evangelista Purkyne University in Usti nad Labem – Czech Republic

Abstract

Solar and stellar flares have been modelled using radiation hydrodynamical (RHD) codes since more than three decades and their current versions incorporate new physics as well as modern numerical methods. Namely the radiative-transfer parts, being time-dependent, are based on efficient accelerated lambda iteration (ALI) techniques, coupled to linearized and/or preconditioned kinetic equations.
This contribution will focus on comparison of two autonomous, methodologically different RHD codes, Flarix and RADYN, and their use to model the solar flare processes. RADYN code was developed by M. Carlsson at the University of Oslo for chromospheric modelling and has been extended and extensively used by others (J. Allred, A. Kowalski, G. Kerr etc.) for the flare modelling. Flarix code is being developed at the Astronomical Institute of the CAS in Ondrejov with the primary purpose of the flare processes modelling.

Both codes can model the time evolution of a 1D atmosphere heated by a specified process, e.g. by the beam electrons propagating from the injection point in the corona down to the lower atmosphere. In such a scenario time scales can be rather short and lead to a fast heating on even sub-second times.
Our aim is to compare Flarix and RADYN codes using exactly the same setup and model conditions. Although such a comparison was never done successfully before for this type of codes, we will present a close agreement between time evolution of modelled atmospheric structure for a test case of the electron beam heating.

*Speaker

sciencesconf.org:radcosmos:223023

Spectroscopic features of an evolved hot chemically peculiar star: HR 62 (B8 III)

Tolgahan Kiliçoğlu and Richard Monnier

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Abstract

Context. The spectrum of the evolved B8 III star HR 62 exhibits weak He-lines as well as strong Mn and P lines. The star therefore resembles both CP3 (HgMn) and CP4 (He-weak PGa) type stars.
Aims. We have analysed the spectrum of the star to derive its chemical abundances. We have also used theoretical surface gravity - effective temperature diagram to clarify its evolutionary status and estimate its mass and age. As a comparison star, we have also analysed the dwarf HR 677 (B8 V) which has the similar effective temperature and projected rotational velocity with those of HR 62.

Methods. The medium resolution (R ˜14000) spectra covering the wavelength range of 4380-7350 A of the late B-type stars HR 62 and HR 677 have been obtained from the Shelyak eShel Spectrograph attached to the 40 cm telescope in Ankara University Kreiken Observatory (AUKR), Turkey. The atmospheric parameters of the stars have been derived by using the photometric measurements in Johnson filters and the Balmer line profiles in the spectra. The abundances have been derived by iteratively adjusting the parameters of synthetic spectra and modelling the selected unblended lines of the elements. For the spectrum synthesis, we used SYNSPEC49 code and its SYNPLOT interface written by I. Hubeny and T. Lanz.

Results. We have found that the atmosphere of HR 62 exhibited slight underabundance of He and Mg, underabundance of Si, slight overabundance of Ne, and overabundance of P and Mn, with respect to the Sun. HR 677, on the contrary, has no any remarkable chemical peculiarities. The mass of 5.4 (solar unit) and age of 8.9E+07 yr. have been estimated of HR 62.
Discussion. We have discussed the origin of the chemical peculiarities of HR 62 and its probable peculiarity class. The effective temperature of the star (12500 K) agrees well with those of HgMn stars. Furthermore, the main sequence end of its evolutionary track also intersects the domain of He-weak PGa stars. These initial results thus suggest that the star can be a transition object between CP3 and CP4 types. However, a more detailed analysis with a higher resolution spectrum including bluer regions ($<$ 4380 A) is needed for a clear conclusion.

*Speaker

sciencesconf.org:radcosmos:220297

Tracing physical processes affecting spectral formation in the low luminosity B[e] stars of the FS CMa group

Daniela Korcakova*[1], Steven N. Shore[2], Anatoly Miroshnichenko[3,4], Sergey V. Zharikov[5], Tereza Jerabkova[1], Radek Kricek[1], Nela Dvorakova[1], Viktor Votruba[6], Nadine Manset[7], and Miroslav Slechta[8]

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Abstract

We discuss specific phenomena influencing the spectral formation in the FS CMa stars, a collection of apparently related low luminosity B[e] stars. Despite their relatively small number (_˜70 members and candidates), this largely overlooked group presents a range of intriguing spectroscopic anomalies. In contrast to other B[e] stars and almost every known stellar group, the evolutionary status of FS CMa stars remains a puzzle. Progress requires constructing physically appropriate synthetic spectra. However, radiative transfer in the FS CMa stars is quite complicated. Strong redistribution of energy from UV to visual and IR results from the UV Fe II curtain, which is observed in, e.g., LBVs and classical novae but not in classical Be stars. The circumstellar medium is not static, and even the inferred outflows are variable. Accelerated and decelerated layers or structures have been observed. The observed flow velocities do not exceed several hundreds km/s, definitely ruling out employing any simplification, such as the Sobolev method. The radiative transfer has to be solved from dense to low-density environment including not only atomic properties, but also dust opacities. Last but certainly not least is a complication related to the structure of the circumstellar medium, which is neither symmetric nor homogeneous and shows large scale changes on time scale of months.

*Speaker

sciencesconf.org:radcosmos:216533

Inclusion of inhomogeneities in static NLTE model atmospheres

Jiří Kubát*[1] and Brankica Kubátová[1]

[1]Astronomický ústav AV ČR, 251 65 Ondřejov – Czech Republic

Abstract

Presence of inhomogeneities (i.e. clumping) is a generally accepted property of stellar winds. However, in static stellar atmospheres, clumping is usually not considered at all. We describe implementation of clumping to our NLTE model atmosphere code. We present test results and estimate the effect of clumping on atmospheric structure and emergent radiation.

*Speaker

sciencesconf.org:radcosmos:220432

3D Monte Carlo Radiative Transfer in inhomogeneous massive star winds – application to resonance line formation

Brankica Kubátová*[1]

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Abstract

The true mass-loss rates from massive stars are important for many branches of astrophysics. For the correct modeling of the resonance lines, which are among the key diagnostics of stellar mass-loss, the stellar wind clumping has been found to be very important. To incorporate clumping into a radiative transfer calculation, three-dimensional (3D) models are required. Various properties of the clumps may have a strong impact on the resonance line formation and, therefore, on the determination of empirical mass-loss rates.
In this talk we will present our full 3D Monte Carlo radiative transfer code for inhomogeneous expanding stellar winds in which we incorporate the 3D nature of the wind clumping. We use set of the parameters which describe dense as well as the tenuous wind components. At the same time, we account for non-monotonic velocity fields. We will show how the 3D density and velocity wind inhomogeneities strongly affect the resonance line formation. A set of representative models for various sets of model parameters and their influence on the resonance line formation will be presented.

*Speaker

sciencesconf.org:radcosmos:224940

The Brightest Stars in the Universe as Extragalactic Probes of Cosmic Abundances and Distances.

Rolf Kudritzki*[1,2]

[1]University Observatory Munich – Germany
[2]Institute for Astronomy, University of Hawaii – United States

Abstract

The determination of chemical composition and distance is crucial for investigating the formation and evolution of star forming galaxies. Stellar absorption line studies based on quantitative spectroscopy provide an attractive alternative to the standard techniques using the strong emission lines of HII regions for chemical composition or stellar photometric methods for distances. I will introduce a number of newly developed methods:
- multi-object spectroscopy of individual blue and red supergiant stars, the brightest stars in the universe at visual and NIR wavelengths,
- NIR spectroscopy of super star clusters,
- optical spectroscopy of the integrated light of stellar populations in the disks of star forming galaxies,
- the flux-weighted gravity luminosity relationship for distance determinations
and present results accumulated in the last two years. I will then discuss the scientific perspectives and potential of these methods for the use of ELTs.

*Speaker

sciencesconf.org:radcosmos:225452

NLTE line blanketing

Thierry Lanz[1]

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Abstract

Accounting for all opacities with a detailed description is key to understand radiation transfer through any medium, hence to be able to diagnose quantitatively and accurately the physical conditions in this medium.

I present key mathematical and physical advances made in the 1980's and 1990's that provided a solid footing to NLTE stellar spectrum analyses.

[*]Speaker

sciencesconf.org:radcosmos:229651

Stellar Population Synthesis

Claus Leitherer*[1]

[1]Space Telescope Science Institute – United States

Abstract

Population synthesis models aim to reproduce the spectral energy distributions of stellar systems ranging from single clusters to entire massive galaxies. Model atmospheres play a crucial role in realistic models, as empirical spectral libraries are often incomplete and/or cover limited wavelength ranges. The goal of the modeling is to learn about structural parameters, star-formation histories, chemical evolution, and more. I will discuss recent results and current challenges. The emphasis will be on stellar aspects but some processes related to the interstellar medium will be covered as well.

*Speaker

sciencesconf.org:radcosmos:220377

Exoplanetary Atmospheres

Nikku Madhusudhan*[1]

[1]University of Cambridge (CAM) – United Kingdom

Abstract

Exoplanetary discoveries in the past two decades have unveiled an astonishing diversity in the physical characteristics of exoplanetary systems, including their orbital properties, masses, radii, equilibrium temperatures, and stellar hosts. Exoplanets known today range from gas-giants to nearly Earth-size planets, and some even in the habitable zones of their host stars. Recent advances in exoplanet observations and theoretical methods are now leading to unprecedented constraints on the physicochemical properties of exoplanetary atmospheres, interiors, and their formation conditions. I will discuss the latest developments and future prospects of this new era of exoplanetary characterization. In particular, I will present some of the latest constraints on atmospheric chemical compositions of exoplanets, made possible by state-of-the-art high-precision observations from space and ground, and their implications for atmospheric processes and formation conditions of exoplanets. The emerging framework for using atmospheric elemental abundance ratios for constraining the origins and migration pathways of giant exoplanets, e.g. hot Jupiters, will also be discussed. A survey of theoretical and observational directions in the field will be presented along with several open questions on the horizon.

*Speaker

sciencesconf.org:radcosmos:226551

Polarized line formation with Paschen-Back effect and partial frequency redistribution

Sampoorna Malali*[1], Nagendra K.n.[2], Sowmya K.[3], Stenflo J.o.[4,5], and Anusha L.s.[3]

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[5]Istituto Ricerche Solari Locarno, via Patocchi, CH-6605 Locarno-Monti, Switzerland

Abstract

Quantum interference between the hyperfine structure states are known to produce a depolarization in the line cores of the polarized spectrum of the Sun (the Second Solar Spectrum). The presence of an external magnetic field in the line forming regions modifies these signatures through the Hanle, Zeeman, and Paschen-Back effects, depending on the strength of the magnetic field. In an earlier paper, Sowmya et al. (2014, ApJ, 786, 150) derived the relevant partial frequency redistribution (PFR) matrix for scattering on a two-level atom with hyperfine structure splitting and in the presence of arbitrary strength magnetic fields (including the Paschen-Back effect regime). In this paper we solve the problem of polarized line transfer in a magnetized atmosphere, including this PFR matrix. For this purpose, we apply a scattering expansion method which is based on orders of scattering approach. In this paper, we present the results on the combined effects of Paschen-Back effect and PFR on the polarized line profiles of Na I D2.

*Speaker

sciencesconf.org:radcosmos:220337

Effects of angle-dependent partial frequency redistribution on polarized line profiles

Sampoorna Malali*[1]

[1]Indian Institute of Astrophysics, Koramangala, Bengaluru – India

Abstract

Scattering of the anisotropic radiation field by atoms and molecules gives rise to the so-called second solar spectrum (the linearly polarized spectrum of the Sun). The partial frequency redistribution (PRD) in line scattering is essential for interpreting the observed linear polarization in strong resonance lines. This polarization is particularly sensitive to the form of the PRD function used in the polarized line transfer equation. For practical applications in astrophysical line formation theory, the angle-averaged PRD functions are commonly used in the literature. This is because the use of angle-dependent PRD complicates the radiative transfer problem both analytically and numerically. In this talk we present our work on polarized line formation with angle-dependent PRD. We discuss techniques developed to handle the angle-dependent PRD functions and the numerical methods to solve the concerned polarized transfer equation. We show that the angle-dependent effects are somewhat less important for scattering polarization in the absence of magnetic fields, while they play an important role for line polarization in the presence of magnetic fields.

*Speaker

sciencesconf.org:radcosmos:218785

Polarized line formation in spherically symmetric expanding atmospheres

Megha A.[1], Sampoorna Malali*[1], Nagendra K.n.[1], Anusha L.s.[2], and Sankarasubramanian K.[3,4]

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[4]CESSI, IISER, Kolkata, India

Abstract

In this paper we consider the problem of polarized line formation in the spherically symmetric expanding atmospheres. The presence of velocity fields in the line forming regions produces Doppler shift, aberration of photons and also gives rise to advection. All these effects can modify the amplitudes and shapes of the emergent Stokes profiles. However, in this paper, we consider only non-relativistic regime wherein mainly Doppler shift effects are significant. Thus only Doppler shift terms are considered in the polarized transfer equation and aberration and advection terms are ignored. For the solution of the concerned polarized transfer equation we use the comoving frame formulation, and apply the Accelerated Lambda Iteration (ALI) method. We present the results by considering the scattering on a two-level atom, including the effects of partial frequency redistribution (PFR). The polarized line profiles would be shown for few velocity laws representative of expanding spherical atmospheres. It is shown that the degree of polarization in the lines sensitively depends on the extendedness R, and velocity gradient dV/dr within the atmosphere. We also present a comparison of polarized profiles computed under complete frequency redistribution (CFR) and PFR in the case of static as well as expanding atmospheres.

*Speaker

sciencesconf.org:radcosmos:220335

Polarized line scattering theory with applications in astrophysical radiative transfer: a historical perspective

Kanakatte Nanjundarao Nagendra*[1]

[1]Indian Institute of Astrophysics, Bengaluru – India

Abstract

Ivan Hubeny did a fundamental work in the theory of partial frequency redistribution (PFR) and radiative transfer, for more than two decades in the early part of his career. One of the most elegant works of Ivan with his collaborators in that period is the "theory of generalized redistribution functions (GRFs)" for multi-level atoms (the so called Hubeny, Oxenius, Simonneau: HOS theory). This ground breaking work on GRFs represents the high point of his contribution to this field. Some of these GRFs are already incorporated in the well known line transfer codes used in the realistic modeling of the observed spectra. The impact of the papers by Ivan on the theory of PFR and line formation, is far reaching and deep, apart from his important work on pure radiative transfer theory. He worked very extensively on applications of the radiative transfer equation (RTE) to a variety of astrophysical situations. The examples of these are:- the improvement of the complete linearization method; extension of ETLA method to include PFR; the work on scaling laws with PFR in probabilistic radiative transfer; and the modeling of the solar Lyman-alpha, Lyman-beta, H-alpha system, among many other topics.

In the first part of this review we include in detail, the relevant literature on the derivation of the unpolarized and polarized PFR functions/ matrices until the current year. A brief review of the work on polarized scattering phase matrices would be given. The phase matrices were derived assuming frequency coherent scattering. Since 1970s the formulation and use of polarized redistribution matrices in RTE has become a standard practice. To a good approximation the redistribution matrices may be expressed as a product of phase matrices and redistribution functions. However a realistic treatment of polarized line scattering requires the use of redistribution matrices themselves in the transfer equation. A survey is made of the literature on the derivation of the PFR functions/ matrices derived by classical, semi-classical, and quantum mechanical formulations, apart from the approximate, and heuristic approaches. In the second part of this review, we dwell upon the numerical methods of solving the NLTE polarized/ unpolarized line RTE with PFR. A historical account is given of the escape probability methods, the classical direct methods, the iterative methods, and other methods like scattering expansion method, etc. Contributions of Ivan to some of these methods are highlighted.

In the third part of this review we give an account of the PFR matrices derived for specific physical mechanisms. Of particular interest are the PFR matrices for:- weak field Hanle effect; Hanle-Zeeman regime; J and F state quantum interference; Paschen-Back effect; lower

*Speaker

level polarization etc. We also present a review of the methods for polarized RTE in planar, spherical and multi-D media in both the static and moving atmospheres. A comparison is made of the traditionally used angle-averaged approximation to PFR, and the angle-dependent PFR.

Finally, the greatest creation of Ivan with Dimitri Mihalas is the publication of the Magnum opus "Theory of Stellar Atmospheres: An introduction to astrophysical non-equilibrium quantitative spectroscopic analysis" in 2014. Every word of the title speaks for itself. No book has ever been written with such a clarity and depth in the theory, covering at the same time a vast landscape of techniques in the theory of stellar atmospheres. Already known as 'SA3', the book represents a fine gift to the Astrophysical community, and remains evergreen in the decades to come.

Astroserver Live - Online spectral analysis with Tlusty models

Peter Nemeth*[1]

[1]Astroserver.org – Hungary

Abstract

Tlusty is a general open-source tool to model stellar atmospheres. The fine solutions and the way of its implementation makes it a complex, powerful, and yet flexible professional tool; the best on the market. Although Tlusty is freely available, users pay a price, which is the time spent climbing the learning curve to use the code routinely and efficiently. Driven by this experience we have developed XTgrid, a spectral analysis procedure for Tlusty. Next, to extend the user base of Tlusty and help non-LTE stellar spectroscopy, we endeavoured on developing an online interface for XTgrid: Astroserver Live. A service that makes classical spectral analyses available in a web-browser. We have integrated XTgrid with Tlusty/Synspec to fit UV-optical-IR stellar spectra and designed a website to guide users through data submission and parameter configuration. Our goal is to make the work with Tlusty as simple as uploading an observation and specifying its resolution. The procedure carries out the rest of the analysis in an automated way using the Astroserver.org computing facilities.

Experienced users can apply their own keyword files, compile their own version of Tlusty and interact with the fit procedure to make the most out of the capabilities of Tlusty/Synspec and the service. Among many other features, users can combine data sets from different instruments in a single run, or model the components of double-lined spectroscopic binaries. With these features the Live tool allows one to carry out detailed analyses of individual targets or to evaluate sample properties in large surveys. We introduce both applications through examples.

The computational demand of the Live tool, just like Tlusty models, can be heavy and analyses with metal line-blanketed models can be lengthy, therefore we offer a "sandbox" version, which is limited to models with H, He, C, N, O opacities and suitable for trying and testing the web tool.

*Speaker

sciencesconf.org:radcosmos:220376

MontAGN - A 3D Radiative Transfer Code for the Modelling of Active Galactic Nuclei and Super Star Clusters

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Abstract

We aim to present MontAGN (Monte Carlo for Active Galactic Nuclei), a 3-dimensional radiative transfer code developed in Python 2.7 for the modelling of active galactic nuclei (AGNs) and super star clusters (SSCs) emission in the near-infrared. In this code photons are propagated under the form of packets taking into account scattering, absorption, re-emission, temperature update and polarisation. Silicate, parallel and perpendicular graphite grains and several dust structures are supported, including radial, spherical power and hierarchically clumped density laws, clouds, shells, torus geometries and constant density cylinders. Other structures may also be defined by users. Polycyclic aromatic hydrocarbon (PAH) will be soon included. MontAGN is capable of constructing SEDs, maps and 3D visualisations from the output. It is also possible to use parallelisation with MontAGN. For the simulations of AGNs, we compared our results with the Monte Carlo radiative transfer code STOKES as well as observations of NGC 1068, a Seyfert 2 AGN. For the SSCs, we compared our results with the models calculated by Whelan et al. 2011. The code successfully reproduced major features, although several upgrades and improvements are still needed in the future.

*Speaker

sciencesconf.org:radcosmos:223225

Atmospheric parameters and chemical abundances of pulsating Beta Cephei stars in open clusters.

Ewa Niemczura*[1] and Tomasz Różański*[1]

[1]University of Wrocław, Poland

Abstract

Beta Cephei stars are massive, non-supergiant, intrinsic variables. Theoretical investigations indicate that their pulsation mechanism strongly depends on the abundance of heavy elements. Until now, hundreds of these B-type variables were discovered photometrically, but only for a small sample spectroscopic data were investigated. We present the results of the investigation of high-resolution and high signal-to-noise spectra of Beta Cephei stars in the young open clusters. We use the spectrum synthesis method and TLUSTY and SYNTHE codes to calculate models of the atmospheres and synthetic spectra. For all stars, we determine effective temperatures, surface gravities, rotational velocities and chemical abundances. This allow to determine the relationships between chemical abundances and pulsational parameters of Beta Cephei stars. Moreover, the atmospheric parameters are necessary constraints for future asteroseismology, an independent method of studying stellar interiors and evolution.

*Speaker

sciencesconf.org:radcosmos:223334

Task-based Radiative Transfer Methods in the DISPATCH Code Framework

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Abstract

We have recently introduced a high-performance simulation framework that allows semi-independent, task-based updates of a collection of 'patches' in space-time (MNRAS 477, 624, 2018). A hybrid MPI/OpenMP execution model is adopted, where OpenMP threads on each compute node are assigned tasks by a rank-local 'dispatcher', which selects tasks that are ready for updating from a set of tasks generally much larger than the number of hardware threads. Mesh refinement may be static or dynamic, and patches may be stationary or moving. A feature of decisive importance for the overall performance of the framework is that time steps are determined and applied locally; this allows potentially large reductions in the total number of updates required in cases when the signal speed varies greatly across the computational domain.

In this talk I will focus on describing the various radiative transfer methods that have been implemented in the DISPATCH framework. One class of methods uses long characteristics inside patches, with rays along the principal axes, face diagonals, and space diagonals, while another class of methods uses short characteristics, allowing arbitrary ray directions. All methods allow multi-bin solutions, with opacities and source functions supplied by lookup-tables, optimized by using loop vectorization.

*Speaker

sciencesconf.org:radcosmos:229442

53

maKe Atoms Simple (KAS): a tool for create, manipulate and build model atoms.

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Abstract

Part of the input data required for all NLTE codes include collected information of the atomic species of interest via the so called model atoms. These are often not public, making difficult the comparison between different codes. Here we present the IDL/GDL code maKe Atoms Simple (KAS); a code that collect atomic data and built model atoms for NLTE radiative transfer codes such as TLUSTY.
One of the updates in the latest version of TLUSTY has the option to include a suite of collisional processes in the form of tables with temperature vs. collisional rates. This update update also allows for the identification of atomic levels in order to match them properly with the SYNSPEC's linelist input file. Some examples and comparisons between different collections of atomic data are presented here together with the resulting synthetic spectra.

*Speaker

sciencesconf.org:radcosmos:225288

Gould's Belt and Beyond

Jan Palous*[1]

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Abstract

Expanding supershells are powered by winds of young and massive stars and by supernova explosions. We explore the results of the local supershell expansion: the Gould's Belt. With GAIA astrometric data we derive kinematical parameters of the Gould's belt and compute formation places of its young stars and OB associations. Their kinematics shows that they have been formed within a sheet-like region about 20 Myrs ago. The Gould's belt is compared to the galactic supershell GS242-03+37, which can be explained as expanding structure more than 100 Myr old. There, the formation of star clusters started about 40 Myr ago, when was the ISM density increased due to galactic differential rotation. Similarly in the Solar vicinity, after about 50 Myr of expansion, the star formation process was triggered in a supershell walls, where the density of the ISM has been increased, creating young stars and OB asso-ciations of the Gould's belt.

*Speaker

sciencesconf.org:radcosmos:220295

The challenges of observing, calibrating, and modeling stellar spectral energy distributions

Carlos Allende Prieto*[1]

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Abstract

With optical and quantum efficiency on the rise and spectrographs becoming massively multiplexed, measuring spectral energy distributions of astronomical sources with accuracy remains a challenge. In addition to atmospheric refraction, extinction, and variability, and limited apertures of instrument entrance slits and optical fibers, accurate calibration is hampered by issues such as a limited choice of reliable standard stars. Modeling stellar spectral energy distributions has seen good progress, but some weaknesses remain, especially for late-type stars. This talk will provide an overview of these matters and discuss observation, calibration, and modeling strategies for future large spectroscopic surveys.

*Speaker

Heavy-Metal Abundances in DO-type White Dwarfs

Thomas Rauch*[1]

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Abstract

Spectral lines of a variety of trans-iron elements were identified in high-resolution ultraviolet spectra of DO-type white dwarfs. Abundance determinations by means of non-local thermodynamic equilibrium stellar-atmosphere techniques have shown that, without exception, their abundances are unexpectedly strong supersolar (up to about five dex), much higher than predicted by asymptotic-giant-branch nucleosynthesis calculations. We present our analyses and discuss the photospheric trans-iron element prominence.

*Speaker

sciencesconf.org:radcosmos:220298

A spectroscopic and kinematical analysis of the hottest white dwarfs from the SDSS DR14

Nicole Reindl*[1], S. O. Kepler[2], Stephan Geier[3], and Martin Barstow[4]

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Abstract

Hot white dwarfs (Teff> 45kK) serve as powerful galactic and cosmological tools. They can be utilized to investigate the properties of weakly interacting particles, to check if there exists a gravitational field effect on the fine structure constant, and to derive the age of the Galactic halo. Because of their high luminosities compared to the cooler white dwarfs, hot white dwarfs can be studied not just in the solar neighbourhood, but also in the thick disk and halo population. However, due to their short evolutionary timescales, hot white dwarfs are relatively rare objects, requiring large sky surveys to detect them. Here, we present results of our non-LTE spectral analysis of several hundred of the hottest white dwarfs from the SDSS DR14 and discuss the effect of metal line blanketing on the derived effective temperatures and surface gravities. In addition we present a study of their galactic distribution based on Gaia data.

*Speaker

sciencesconf.org:radcosmos:219910

New tool for atmospheric parameters determination and abundance analysis of hot stars

Tomasz Różański*[1] and Ewa Niemczura[1]

[1]University of Wrocław – Poland

Abstract

As most of our knowledge about structure and evolution of stars comes from interpretation of their electromagnetic spectrum, it is very important to develop efficient methods for rapid and automatic atmospheric parameters determination. We have implemented scientific software that uses non-LTE atmospheric models and theoretical spectra derived with SYNSPEC and TLUSTY codes. This Python3 based package includes tested algorithm for atmospheric parameters determination and abundance analysis of B-type stars, and gives tools for interpolation on grid of atmospheric models or theoretical spectra, computation of grid of spectra, and spectrum fitting. The most important advantage of the new package is that it uses prepared, well described blocks that allow the user to build well suited algorithm for atmospheric parameters determination of chosen type of stars or just use implemented algorithm for B-type stars. Our package is tested on a sample of well known B-type stars.

*Speaker

sciencesconf.org:radcosmos:223255

Insight on the sources of cosmic reionisation and their stellar and ISM properties

Daniel Schaerer*[1]

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Abstract

I will present new/recent studies on confirmed Lyman continuum leakers and related star-forming galaxies based primarily on new HST observations and on the modeling of emission lines and UV absorption lines.

This work provides new insight on sources of cosmic reionization, their ISM, stellar population and ionizing photon production, as well as on the mechanisms allowing for the escape of Lyman continuum radiation. It also also yields important diagnostic tools to identify and study these sources with upcoming facilities and instruments, such as the JWST.

*Speaker

Examining magnetospheric accretion in Herbig Ae/Be stars through near-infrared spectroscopic signatures

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Abstract

Models of magnetically driven accretion and outflows reproduce many observational properties of T Tauri stars. For the more massive Herbig Ae/Be stars, the corresponding picture is not well established. Nonetheless, it is expected that accretion flows in pre-main sequence stars are guided from the circumstellar disk to stellar regions of high latitude along the magnetic field force lines inside a magnetosphere. Using near-infrared multi-epoch spectroscopic data obtained with ISAAC, CRIRES, and X-shooter on the VLT, we examined magnetospheric accretion in the two Herbig Ae stars HD101412 and HD104237. Spectroscopic signatures in He I 10830 and Paschen gamma, two near-infrared lines that are formed in a Herbig star's accretion region, show temporal modulation. This modulation is for both stars governed by their rotation periods, which we determined from the data. For HD101412 we could show that our spectroscopic observations can be explained within the magnetic geometry that we established earlier from magnetic field measurements. For HD104237 we were able to further constrain the inclination of the star's rotation axis. We intend to apply this method to a larger sample of Herbig Ae/Be stars to learn more about their rotation properties and the accretion mechanisms at work in Herbig stars.

*Speaker

sciencesconf.org:radcosmos:221441

Methods to solve multi-dimensional polarized radiative transfer equation with line scattering, magnetic fields and partial frequency redistribution

Anusha Lokanathapura Seetharamabhasari*[1]

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Abstract

Solar observations and numerical simulations have proved the existence of enormous inhomogeneous structures in the solar atmosphere. Solving polarized radiative transfer equation is a powerful means of understanding the effects of these inhomogeneities on the spectrum emerging from the Sun. To take spatial inhomogeneities into account, a solution of the transfer equation in multi-dimensional geometries is necessary. Here we present a summary of the high speed iterative methods that we developed in a series of papers, to solve multi-dimensional polarized radiative transfer equation and the application of these methods to analyze the observations.

*Speaker

sciencesconf.org:radcosmos:220171

Radiative transfer in an expanding universe

Benoit Semelin*[1]

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Abstract

I will present some aspect of radiative transfert modelling specific to a cosmological setting. This includes both situations where the timescale of cosmological expansion is comparable to at least one of those pertinent for radiative transfer, in which case taking the red-shifting into account is necessary, and situations where radiative transfer is a key factor in the global evolution of the universe. Both situations are most commonly found during the first billion years of the universe: I will for example discuss the process of reionization of the universe and the emission of the 21 cm signal during the Cosmic Dawn.

*Speaker

Breaking the rules: classical novae as testbeds for extending spectral modeling

Steve Shore*[1]

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Abstract

Classical novae are "comparatively simple" single ejection ballistic events that show a rich phenomenology across the spectrum. For the "Fe curtain", they resemble LBVs in fast forward, for complex cool spectra, they mimic R CrB and AGB stars. They even (under extraordinary conditions) show shock interactions within a stratified dense medium, as in symbiotic stars. All this happens in a non-stationary, non-spherical, highly fragmented medium in which the chemical properties may not even be completely homogeneous. Classical novae form dust dust (think supernovae but with far lower mass and not radioactive), show molecular phases (think mergers, e.g. V1309 Sco), display a very wide range of ionizations with a central illuminating source whose spectrophotometric properties are changing in real time (think planetary nebulae in real time). They are even binaries in which the accretion restarts after some time, changing yet again the illumination of the ejecta. What more could you ask for?

*Speaker

sciencesconf.org:radcosmos:225133

Transformative Advances in our Knowledge of Accretion Physics of Accreting White dwarfs in Explosive Interacting Binaries

Edward M. Sion*[1]

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Abstract

The powerful capabilities of the spectral synthesis codes developed by Ivan Hubeny and collaborators (TLUSTY, SYNSPEC, DISKSYN) have revolutionized the analysis of far ultraviolet spectra of accreting white dwarfs in interacting binaries, using orbiting observatories (IUE, HST (FOS, GHRS, STIS, COS), FUSE). These analytical tools have opened up a broad array of new insights into accretion physics in compact binaries and wider systems with giant donor companions. Specifically, detailed investigations of cataclysmic variables (CVs) (dwarf novae, nova-like variables, post-novae, recurrent nova, symbiotic variables, symbiotic novae) have yielded a treasure trove of physical parameters of the hot accreting components including surface temperatures, rotational velocities, chemical abundances, surface gravities, accretion rates). This has led to the construction of a big overall picture of accretion physics and CV evolution. Examples of these advances in the area of accreting white dwarfs will be presented. Numerous Ph.D dissertations, Masters theses, undergraduate research projects culminating in peer-reviewed publications for the students, have been spawned through the application of Ivan's public downloadable codes to FUV spectra.

*Speaker

sciencesconf.org:radcosmos:223850

Formation of strong emission lines in stellar accretion disks: The link between observations and models

Benjamin Tessore*[1], Jerome Bouvier[2], Christophe Pinte[2], and Francois Menard[2]

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Abstract

A vast number of planetary systems are found close to young stellar objets, revolving at distances less than 1 AU. These planetary systems are yet inaccessible to the new generations of instruments.
Investigating the origin and the evolution of these systems is the goal of the Star-Planet-Inner Disk Interactions (SPIDI) project.
The project's strategy includes synergies between observational techniques and numerical modeling of planetary systems embedded in the accretion disk of their hosting star. Radiative transfer simulations of the formation of strong emission lines (Na D, helium, hydrogen lines...) will shorten the gap between the models and the observations hence between what is known and what's remain.

*Speaker

Neutron star model atmospheres

Klaus Werner*[1]

[1]Eberhard Karls Universität Tübingen – Germany

Abstract

We present our methods to model neutron star atmospheres and applications of these models to spectral analyses.

*Speaker

sciencesconf.org:radcosmos:221193

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