The general Be-star enigma unveiled by space photometry?

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Abstract

Observations of several bright Be stars with the BRITE and SMEI space photometers are combined to deduce and define four hierarchical clock levels. The lowest level (with the highest frequency) consists of nonradial pulsation modes with frequencies of O(1 c/d). The next two levels, at O(0.1 c/d) and O(0.01 c/d), are constructed from combination frequencies of NRP modes and govern the mass loss. Perhaps depending on the frequencies, Levels 2 and 3 may be merged. The fourth and slowest clock determines the efficiency of the mass-loss process. The full network provides a parametric (as opposed to physical) explanation of the typical mass-loss behavior (inferred from photometric outbursts) of classical Be stars on all timescales known to date.

*Speaker

Tracking out the brighten-ups development and gas-dynamical conditions of the accreting matter in two gamma-Cas binary stars

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Abstract

We study the behavior of two binary stars of the gamma - Cas type: gamma Cas and X Per. Indications of flare's or flickering activity by the manifestation of brightness variability in their light curves are presented. The common suggestion is that variations in luminosity for Be stars is coming from accretion wind or disc. According to the physical conditions and properties of the interacting flows between the components, we imply some possible gas-dynamical sources of the brighten-ups appearance in these two objects. We make a relation to the probabable polarization effects in gamma Cas. Therefore, the calculation of polarization profiles on the base of the PolarBase data, taken for the same observational period is presented.

*Speaker

Periodic variability of Gamma Cas in space photometry and groundbased spectroscopy

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Abstract

Using observations with the Solar Mass Ejection Imager (SMEI) and the BRIght Target Explorer (BRITE), I have searched for periodic variations of gamma Cas in the time intervals from 2003 to 2011 (SMEI) and 2015 to 2016/17 (BRITE). The 0.8-c/d variability and its fading found by Henry and Smith (2012; observations from 1997 to 2011) are confirmed with SMEI. In the BRITE observations, the only frequency detected is 2.4 c/d. The ratio of these two frequencies is 3.016 +-0.010.

In Hα profiles from the BeSS database, I could for the first time detect the orbital 0.005-c/d variability in the structure of the emission profiles, instead of just in the radial velocity of the wings. This variation is asymmetric and only visible in the red half of the line.

Several possible explanations of these findings are discussed.

*Speaker

From dynamos in stars and disks to gamma Cas

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Abstract

Numerical simulations have led to a considerable enrichment of our repertoire of possible model scenarios for stellar turbulence. At the same time, simulations suffer from significant shortcomings such as the difficulty to cope with the enormous range of time and length scales. Matching simulations with observations is often not very fruitful. Sometimes, however, unexpected features of one model star may turn out to be observed features of another observed star. Being a beginner in the gamma Cas phenomenon, my aim is to highlight some recent findings that might be relevant to the discussion of gamma Cas. I will begin with a discussion of possible turbulence zones in rapidly rotating massive stars. In other similar circumstances, the extent and depth of turbulence zones can be highly latitude dependent, offering therefore food for thought in guiding our intuition about possible sites of magnetic field generation. Another important site of magnetic field generation is the decretion disk. I will therefore discuss properties of such dynamos relevant to the gamma Cas phenomenon.

*Speaker

Accreting white dwarf models

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Abstract

A Suzaku observation of gamma Cas in 2011 detected rapid X-ray spectral hardening events on timescales of up to _˜1 ksec. A fraction of the X-ray emission is absorbed during these events, suggesting that an X-ray absorbing blob passes over an X-ray line of sight in each event. These absorption events are important for constraining the sizes of the X-ray plasmas and absorbers. Considering reasonable absorbers around gamma Cas (e.g., Be stellar winds, disks) with velocities of _˜< 1e3 km s-1, an X-ray emitting region should have a size of _˜< 1e6 km. This is much smaller than the Be star or its disk, suggestive of a spot on a smaller body such as a white dwarf. In my talk, I will introduce how the accreting white dwarf models fit with the observed gamma Cas X-ray characteristics. The NICER X-ray observatory, which started operation onboard the international space station in 2017, has a very large soft X-ray collecting area as well as extremely high timing resolution and good spectral resolution, enabling to track absorption variation in great details. I will also introduce the initial result of NICER observations of gamma Cas.

*Speaker

EM Cep: The Be Star

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Abstract

On the basis of UBVR photometric data, obtained in the Abastumani Observatory during 1991-1999, a very interesting and unusual flare of the Be star EM Cep has been revealed - increasing of stellar brightness in R pass-band was observed together with the simultaneously decreasing of brightness in U band. Duration of the flare was over two hours. We estimated the percentage of brightness increase during the flare and brightness decrease of the corresponding anti flare and the minimum amount of the mass lost during this event. The different explanations for the nature of the star were investigated, from a binary companion to a pulsating star to a magnetic reconnection event. The present data point to the star being likely a single magnetic Be star, however to finally settle the question on the EM Cep nature, new observations are required.

*Speaker

MHD protostar-disc interaction.

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Abstract

Magnetospheric accretion of circumstellar disc material is a mechanism that affects a variety of astrophysical objects, from young stellar objects in both the low- and high-mass regimes, to compact objects such as white dwarves and neutron stars. Within this picture, the accretion flow in their inner circumstellar disc is channeled along the stellar magnetic field lines and ultimately shocks the stellar surface, inducing an exchange of mass, angular momentum and energy that can spin up/down the star itself and modify its intrinsic evolution. We will look at preliminary results of non-ideal 2.5-dimensional simulations of the magnetised surroundings of rotating young stars and explore how different parameters of the problem can affect the accretion dynamics and change their spin evolution and emission properties.

*Speaker

Two stars X-raying the origin of the gamma-Cas phenomenon

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Abstract

We report on the study of two gamma-Cas analogs : HD45314 and pi Aqr. The former star is the hottest gamma-Cas object known. Its optical spectrum was monitored over 20 years, revealing spectacular variations. X-ray observations were collected at some key phases of these variations. Their analysis shows that the X-ray emission softens and becomes fainter as the lines associated to the circumstellar disk vanish. The simultaneity of the X-ray and optical changes suggest an origin of the gamma-Cas phenomenon close to the disk. The latter star was serendipitously discovered to be a gamma-Cas analog. However, it is also a known binary, with a normal non-degenerate companion orbiting close to the disk : if a compact companion exists in the system, it must be far away from the Be star and can thus not accrete material from the Be disk.

*Speaker

An X-ray survey of Oe and Be stars reveals new g-Cas candidates

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Abstract

We have performed a cross-correlation between XMM-Newton and Chandra source catalogues and the list of Be stars contained in the BeSS database. This yielded 84 detections, two-thirds of those having enough counts for spectral analyses. We determined their X-ray luminosities and, when possible, temperature, absorption, and hardness properties. Among the sample, we found seven new objects which can be classified as g-Cas candidates, further populating this peculiar category.

*Speaker

Magnetic fields in B and Be stars

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Abstract

Over the last decade, large spectropolarimetric surveys have established that about 10% of OBA stars host a magnetic field of a few hundred Gauss or more. These magnetic fields are stable over decades, due to their fossil origin, and have simple configurations, often a dipole inclined to the stellar rotation axis. There are however a few exceptions: 100% of Of?p are magnetic and it seems that the population of Am stars is also largely magnetic but with ultra-weak fields of the order of 1 G. Magnetic hot stars also often host a magnetosphere, either centrifugally supported or dynamical, created from wind particles channeled along the magnetic fields lines. Magnetic fields have also been invoked in the past to explain the presence of a circumstellar disk around classical Be stars. However Be disks are Keplerian and not a co-rotating magnetosphere. So far, no large-scale magnetic field has been directly detected at the surface of any classical Be star. Recent numerical simulations have shown that the presence of a strong stellar magnetic field and a Keplerian circumstellar disk are incompatible. However, indirect evidences of the presence of a field has been found for omega Ori and weak fields or small-scale fields could still exist in classical Be stars. In addition magnetic fields in the disk itself is sometimes invoked to explain the gamma Cas phenomenon, without any clear detection.

*Speaker

Be/X-ray binaries

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Abstract

Be/X-ray binaries are interesting objects because they are laboratories that allow us to study the interaction of decretion with accretion disks, that is, the Physics of accretion and the Be phenomenon. In this talk I will present recent results regarding three topics related to the core of the BeXB research. The first one concerns the optical companion and its disk. The second one the neutron star and its X-ray emission. The third one involves the interaction between the two components. The basic question that I will try to answer is what is the observational evidence for i) disk truncation, ii) accretion regimes, and iii) warped disks during giant X-ray outbursts.

*Speaker

The life cycles of viscous decretion disks around Be stars: fundamental disk parameters in the Magellanic Clouds

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Abstract

The viscous decretion disk (VDD) model of Be stars is the best physical model to explain the workings of Be star disks. Two important physical ingredients of this model, however, namely the magnitude of the viscosity (alpha) and the rate at which mass and angular momentum is injected into the disk, remain poorly constrained. In addition, substantial work remains to be done in order to fully understand the life cycles of these disks: how fast they grow and dissipate, for how long they last, etc.

The light curves of Be stars that undergo events of disk formation and dissipation offer an opportunity to study their life cycles and to constrain the disks' fundamental properties. In a recent paper, we have shown that it is possible to constrain the viscosity parameter and the angular momentum loss rate from the star through the viscous disk. In that work, a sample of 81 photometric events of outbursts followed by dissipations of the disk, which we refer to as "bumps", from 54 Be stars in the Small Magellanic Cloud (SMC) were modeled. It was found that the typical angular momentum loss rates associated with the bumps are of the order of _~5x10^(36) g/cm^2/s^2, which is surprisingly below the required values by the current evolutionary models of fast-spinning stars so that the stars do not reach their break-up velocities. We also found that the values of alpha found are typically of a few tenths, consistent with recent results in the literature and with the ones found in dwarf novae, but larger than the current MRI-based theory predicts.

In this contribution, we now focus on Be stars from the Large Magellanic Cloud (LMC). A sample of more than a hundred stars from the OGLE survey, whose light curves usually contain a few bumps, was selected for this study. We discuss the results for the LMC stars and compare them with the ones for their SMC siblings.

Additionally, a new type of disk event was discovered, which we named "Very Long Bumps". These are bumps with time spans of the order of _~6000 days. These Very Long Bumps were not yet identified in other photometric surveys, which may indicate they are peculiar to the Be population in the LMC.

*Speaker

A new method for probing binary companions around Be stars

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[2]Universidade de São Paulo (USP) – Brazil

Abstract

One possible way to form fast-spinning B stars is via mass transfer in a binary system, during which mass and angular momentum are transferred from the more massive star to the less massive one. The end result of the binary system's evolution would a fast-spinning star (the gainer) and a low-mass star (the donor). The low-mass object can either become a degenerate star or a non-degenerate stellar core. To date, only a handful of the latter systems is known, possibly due to the fact that the direct detection of the secondary is rather challenging. We present a novel method for detection of these elusive binaries around classical Be stars, which relies on their effect on the SED. Tidal interactions between the companion and the Be star disk may lead to disk truncation. Given that flux in larger wavelengths comes from the outer parts of the disk, this truncation is translated in the SED as a steepening of its slope in the radio region. Therefore, the detection of this so-called SED turndown strongly suggests the presence of a previously unseen binary. We report on the detection of 8 Be stars with SED turndowns, which correspond to 100% of the sample studied so far. Futhermore, we report that recent results from the multi-technique analysis of 2 of these stars – α Ara and α Col - are consistent with a truncated disk model. Despite the small number statistics, our results suggest the tantalizing prospect that most (all?) Be stars are the end product of binary evolution.

*Speaker

THE MAGNETIC STAR-DISK INTERACTION HYPOTHESIS

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Abstract

Simultaneous far-UV light curves and spectroscopy obtained on gamma Cas in 1996 along with RXTE observations have established several striking correlations. This fact focuses attention on the system's sole source of copious UV and optical fluxes, the Be star. Because we know that the companion of gamma Cas emits negligible UV flux, it can be eliminated as the source of UV and thus X-ray variations. Some UV features can be robust, notably, the UV light curves exhibited a pair of 1-2% dips separated by 10 hours. These dips seem to repeat at the same rotational phase during two other epochs. Also, short- and long-term X-ray variations offer a few fascinating insights. For example, the rapid timescale of ubiquitous X-ray shots requires that this flux component be formed at photospheric densities. In addition, long term X-ray and optical light variations show persistent correlations, especially for "cycles" of _˜70 days. Because the amplitudes of cyclical variations are larger in the optical red than in the blue, the Be decretion disk is likely to be somehow involved in X-ray production. Moreover, the presence of "migrating subfeatures" in UV/optical line profiles implies the presence of small-scale fields that anchor corotating circumstellar clouds. These results support a picture in which magnetic fields from the Be star and the inner disk entangle (the latter is enhanced by a Magnetorotational Instability), create stresses, and trigger the release of high energy electron beams that impact the Be surface and create X-rays. Time permitting, we will adduce evidence that collisions between fast wind streams, emanating from postulated surface magnetic convective cells, and slower streams cause dips in the UV, and sometimes soft X-ray, light curves.

*Speaker

MRI and other instabilities in disks

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Abstract

The talk is planned as an overview of current ideas about the role of magnetic fields in accretion disks. Topics include: the degree of consensus about angular momentum transport by magnetorotational turbulence, the interesting relation between magnetorotational and hydrodynamic shear instability, the role of buoyant instability, and the worrying dependence of dynamos on the magnetic Prandtl number. In addition: the effect of a weak net flux trough the disk on the level of turbulence. If time permits, also the curious phenomenon of 'type II supertransients' and some thoughts about the conditions for producing organized field configurations as used for jet launching.

*Speaker

Suzaku and NuSTAR X-Ray Spectroscopy of γ Cas and HD 110432

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[3]NASA/GSFC – United States
[4]RIKEN – Japan

Abstract

γ Cas and its dozen analogs comprise a small but distinct class of X-ray sources. They are early Be-type stars with an exceptionally hard thermal X-ray emission. The X-ray production mechanism has been under intense debate. Two competing ideas are (i) the magnetic activities in the Be star and its disk and (ii) the mass accretion onto the unidentified white dwarf (WD). We adopt the latter as a working hypothesis and apply physical models developed to describe the X-ray spectra of classical WD binaries containing a late-type companion. Models of non-magnetic or moderately magnetic accreting WDs were applied to γ Cas and its brightest analog HD 110432. The moderately magnetic model yielded reasonable physical values, while the non-magnetic model yielded a too high mass accretion rate. Inspection of high-resolution grating spectra makes the moderately magnetic case more likely than the non-magnetic case. Other possibilities than these two are excluded. We thus conclude that γ Cas and HD 110432 should contain a moderately magnetic WD with a mass respectively of _˜0.7 and 0.9 Mo and an X-ray luminosity equivalent to the mass accretion rate of _˜10 –10 Mo yr-1 if indeed they are Be/WD binaries. We propose some predictions that can be tested with observations: (1) X-ray pulsation due to the WD spin of ≈1 day and (2) a low eccentricity ($<$ _˜ 0.3) in the binary orbit if an analogy to persistent Be/NS binaries holds, and (3) classical novae from other analogues if the mass and the mass accretion rate are much larger than those derived for γ Cas and HD 110432.

*Speaker