THE AGB NEWSLETTER

An electronic publication dedicated to stellar evolution on the asymptotic giant branch and beyond

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Editors: Thierry Forveille and Claudine Kahane (agbnews@obs.ujf-grenoble.fr)

From the editors

Please note that the e-mail address of the AGB newsletter has changed from agbnews@gag.observ-gr.fr to agbnews@obs.ujf-grenoble.fr. The internet address of the computer which hosts the newsletter (to be used for ftp and WWW access) is laog.obs.ujf-grenoble.fr. The announcement we published last month unfortunately had a confusion between our e-mail adress and the internet address of the computer.

Abstracts of recently accepted papers

Properties which cannot be explained by the progenitors of planetary nebulae

Noam Soker[1]

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I classify a large number of planetary nebulae (458) according to the process which caused their progenitors to blow axisymmetrical winds. The classification is based primarily on the morphologies of the different planetary nebulae, assuming that binary companions, stellar or substellar, are necessary in order to have axisymmetrical mass loss on the AGB. I propose four evolutionary classes, according to the binary-model hypothesis:
(a) Progenitors of planetary nebula which did not interact with any companion. These amount to $\sim 10\%$ of all planetary nebulae.
(b) Progenitors which interact with stellar companions which avoided common envelope, $11^{+2}_{-3}\%$ of all nebulae.
(c) Progenitors which interact with stellar companions via common envelope phase, $23^{+11}_{-5}\%$ of all nebulae.
(d) Progenitors which interact with *substellar* (i.e. planets and brown dwarfs) companions via common envelope phase, $56^{+5}_{-8}\%$ of all nebulae.
In order to define and build the different classes, I start with clarifying some relevant terms and processes related to binary evolution. I then discuss kinematical and morphological properties of planetary nebulae that appear to require the interaction of the planetary nebula progenitors and/or their winds with companions, stellar or substellar.

Accepted by ApJ. Supp.

Preprints can be obtained by contacting soker@phys1.technion.ac.il

The rings around the Egg nebula

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We present an eccentric binary model for the formation of the protoplanetary nebula CRL 2688 (The Egg Nebula) which exhibits multiple concentric shells. Given the apparent regularity of the structure in the Egg Nebula, we postulate that the shells are caused by the periodic passages of a companion star. Such an orbital period would have to lie in the range of 100 - 500 years, the apparent time that corresponds to the spacing between the rings. We assume, in this model, that an asymptotic giant branch (AGB) star, which is the origin of the matter within the planetary nebula, loses mass in a spherically symmetric wind. We further suppose that the AGB star has an extended atmosphere (out to ∼10 stellar radii) in which the outflow speed is less than the escape speed; still further out, grains form and radiation pressure accelerates the grains along with the trapped gas to the escape speed. Once escape speed has been attained, the presence of a companion star will not significantly affect the trajectories of the matter leaving in the wind, and the mass loss will be approximately spherically symmetric. On the other hand, if the companion star is sufficiently close that the Roche lobe of the AGB star moves inside the extended atmosphere, then the slowly moving material will be forced to flow approximately along the critical potential surface (i.e., the Roche lobe) until it flows into the potential lobe of the companion star. Therefore, in our model, the shells are caused by periodic cessations of the isotropic wind, rather than by any periodic enhancement in the mass-loss process.

We carry out detailed binary evolution calculations within the context of this scenario, taking into account the nuclear evolution and stellar wind losses of the giant, as well as the effects of mass loss and mass transfer on the evolution of the eccentric binary orbit. ¿From the initial binary parameters that we find are required to produce a multiple concentric shell nebula, and the known properties of primordial binaries, we conclude that approximately 0.3% of all planetaries should go through a phase with multiple concentric shells.

Accepted by ApJ

Preprints can be obtained by contacting soker@phys1.technion.ac.il

Benchmark problems for dust radiative transfer

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When verifying a sophisticated numerical code, it is a usual practice to compare the results with reliable solutions obtained by other means. This work provides such solutions for the wavelength dependent dust radiative transfer problem. We define a set of benchmark problems in spherical geometry and solve them by three radiative transfer codes which implement different numerical schemes. Results for the dust temperature and emerging spectra agree to better than 0.1%, and can be used as benchmark solutions for the verification of the dust radiative transfer codes.

Accepted by MNRAS

Preprints can be obtained by contacting ivezic@astro.princeton.edu

The Effects of Rotation and Stellar Magnetic Field in the Nebular Shapes: LBV Nebulae and PNe

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We review the formation of bipolar nebulae, via stellar rotation, and its application to the formation of bipolar LBV nebulae and planetary nebulae. Also, the effects of the stellar magnetic field are reviewed, and applied to the formation of elliptical and highly collimated planetary nebulae. Two-dimensional hydrodynamical and magneto-hydrodynamical simulations indicate that these processes are efficient in driving bipolar and collimated outflows.

We also discuss recent 3-dimensional, magneto-hydrodynamical simulations confirming that planetary nebula jets and ansae can be obtained by magnetic collimation of their central winds. Jets and ansae form at the polar regions due to the magnetic tension produced by the magnetized winds. It is proposed that the formation of "attached" and "detached" ansae involves two and three winds, respectively. It is shown that rotating jets and point-symmetric nebular shapes can be the result of a precessing star, tidally coupled with a companion.

To Appear in : The Sixth Texas-Mexico conference on Astrophysics, "Astrophysical Plasmas– Near and Far", RevMexAA, Serie de Conferencias, ed. S Torres-Peimbert & R. Dufour, in press
Preprints from ggs@astroscu.unam.mx

Barium stars, galactic populations and evolution *

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In this paper HIPPARCOS astrometric and kinematical data together with radial velocities from other sources are used to calibrate both luminosity and kinematics parameters of Ba stars and to classify them. We confirm the results of our previous paper (where we used data from the HIPPARCOS Input Catalogue), and show that Ba stars are an inhomogeneous group. Five distinct classes have been found i.e. some halo stars and four groups belonging to disk population: roughly super-giants, two groups of giants (one on the giant branch, the other at the clump location) and dwarfs, with a few subgiants mixed with them. The confirmed or suspected duplicity, the variability and the range of known orbital periods found in each group give coherent results supporting the scenario for Ba stars that are not too highly massive binary stars in any evolutionary stages but that all were previously enriched with Ba from a more evolved companion. The presence in the sample of a certain number of "false" Ba stars is confirmed. The estimates of age and mass are compatible with models for stars with a strong Ba anomaly. The mild Ba stars with an estimated mass higher than 3 $M_{\odot}$ may be either stars Ba enriched by themselves or "true" Ba stars, which imposes new constraints on models.

Accepted by Astron. Astrophys.

* Based on data from the ESA HIPPARCOS astrometry satellite

For preprints, contact menes@graal.univ-montp2.fr

Stellar evolution of low and intermediate-mass stars: IV. Hydrodynamically-based overshoot and nucleosynthesis in AGB stars

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The focus of this study is on the treatment of those stellar regions immediately adjacent to convective zones. The results of hydrodynamical simulations by Freytag et al. (1996) show that the motion of convective elements extends well beyond the boundary of the convectively unstable region. We have applied their parametrized description of the corresponding velocities to the treatment of overshoot in stellar evolution calculations up to the AGB (Pop.I, $M_{\rm ZAMS} = 3{\rm M}_{\odot}$).

Our calculations show the 3$^{\rm rd}$ dredge-up already at the 7$^{\rm th}$ thermal pulse, and the dredge-up parameter reaches $\lambda = 0.6$ during the next five pulses. Accordingly, the amount of dredged up ^{12}C is up to $10^{-3}{\rm M}_{\odot}$. Our models develope a small so-called ^{13}C pocket consisting of a few $10^{-7}{\rm M}_{\odot}$. Finally, this treatment of boundaries of convective regions leads to intershell abundances of typically (^{4}He/^{12}C/^{16}O)=(23/50/25) (compared to (70/26/1) in the standard treatment).

Accepted by Astronomy & Astrophysics (Letter to the Editor).
Preprints can be obtained by contacting fherwig@aip.de *or* bloecker@astrophysik.uni-kiel.de,
or via anonymous ftp on 134.245.66.1 *in* /pub/tbloecker/agb/agb_hydro.ps.Z

SiO masers in OH/IR stars, proto–planetary, and planetary nebulae

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We present a search for SiO masers towards a sample of 126 objects including OH/IR stars, proto–planetary and planetary nebulae. All objects are classified as oxygen–rich, and most of them are associated with OH or H_2O masers. SiO masers were found only in variable objects like the OH/IR stars and a few objects classified as proto–planetary nebulae, but with variable central stars that may be part of binary systems. In one object, OH15.7+0.8, which appears to be varying irregularly and most likely recently left the AGB, an SiO maser was tentatively detected. Thus, we conclude that variability and SiO maser emission are closely linked, and that SiO masers disappear very soon after a star has reached the end of the AGB, when pulsation and mass loss cease.

Accepted by Astronomy and Astrophysics Supplement Series

Preprints can be obtained by contacting lnyman@eso.org

On the mass distribution of planetary nebulae central stars

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We apply a method, described in Górny et al. (1997), to derive the masses of 125 central stars of planetary nebulae (PN). This method is self-consistent and distance-independent. It requires the knowledge of the nebular H β fluxes, angular radii and expansion velocities, as well as the stellar visual magnitudes. This method is based on a simple model for the evolution of planetary nebulae, in which the central stars evolve according to the theoretical models of Blöcker (1995) and Schönberner (1983). The results are dependent on the assumed *total* nebular mass. Nevertheless, for any reasonable *total* nebular mass distribution, we find that the range in planetary nebulae central star masses is very restricted: more than 80% of the objects have a central star mass between 0.55 and 0.65$M_\odot$. We show how to convert, in this mass range, the observed PN central star mass distribution into a zero-age post-AGB star mass distribution.

Accepted by A&A

Preprints can be obtained by contacting skg@ncac.torun.pl *or via WWW on* http://www.ncac.torun.pl/~skg/art/sgt97.html *or via anonymous ftp from* ftp.ncac.torun.pl, *as a compressed PostScript file:* /pub/hide/SKG/sgt97.ps.gz

First Results from HIPPARCOS Trigonometrical Parallaxes of Mira-type Variables

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HIPPARCOS trigonometrical parallaxes are given for 16 pre-selected Mira variables. Linear diameters are derived for 8 oxygen-rich Miras with known angular diameters. Comparison with pulsation theory shows that two of them (both with periods over 400 day) are fundamental pulsators, the others (all with periods less than 400 day) pulsate in an overtone. The Mira PL relations in M_K and M_{bol} are calibrated for oxygen-rich overtone pulsators adopting slopes for these relations from LMC data. A mean LMC distance modulus of 18.54 is derived; this is very close to that of 18.57 derived from the Cepheids. The uncertainty in the value derived from the Miras is estimated to be less than 0.2 mag. The absolute magnitude of the only carbon-rich Mira in the sample, R Lep (period of 427 day), indicates that it is a fundamental pulsator. Other stars discussed individually are: the symbiotic Mira, R Aqr; the double-period Mira, R Cen; and, two Miras with decreasing periods, R Aql and R Hya.

Accepted by MNRAS

Preprints can be obtained by contacting paw@saao.ac.za
or via WWW on http://www.saao.ac.za/research/papers/papers.html

On the hydrogen deficient nature of Z Umi

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Z Ursa Minoris was classified by Benson et al. (1994) as a R Coronae Borealis (RCB) variable star from its light variations. Hydrogen deficiency, which is a defining feature of RCB stars, was not established. To investigate this aspect we have obtained high resolution spectra in both blue (4200-4630Å) and red (5050-7950Å) regions. Lines of the CH molecule (G band) at about 4300Å, which are present in spectra of N-type carbon stars are weak or absent in the spectrum of Z UMi indicating its hydrogen deficient nature and membership of the rare class of RCB variables.

Accepted by PASP
Preprints can be obtained by contacting aruna@iiap.ernet.in

Observation of inhomogeneities in the wind of the luminous red supergiant μ Cep

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Long-slit spectrograms of the circumstellar envelope of the M2Ia luminous supergiant μ Cep are presented. This cool wind emits fluorescent KI 7665-7699Å lines and has been resolved along two north-south slits, located $5''$ and $10''$ west from the star. The angular resolution was $\sim 0.6''$. A low spectral resolution of 40 km s^{-1} , i.e. about the emission line width, was used, permitting to be sensitive and to detect KI emission up to $\sim 60''$ from the star. The distributions of KI line emission along these two strips display bumps and breaks, which suggest that important inhomogeneities exist in the flow. Their apparent size is about $1''$-$3''$, corresponding to $\sim$1-3 10^{16} cm for a distance of 830pc. The data suggest that density contrasts of an order of magnitude occur in the wind at the above scales, although interpretation of the KI line intensity is subject to uncertainties concerning ionization and line transfer in a clumpy medium. Assuming that these inhomogeneities are in fact arc-like shells ejected episodically by the star, a typical mass-loss timescale of $\sim$1000 years is derived.

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For preprints, contact: mauron@merlin.graal.univ-montp2.fr

The Effects of Rotation and Stellar Magnetic Field in the Nebular Shapes: LBV Nebulae and PNe

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We review the formation of bipolar nebulae, via stellar rotation, and its application to the formation of bipolar LBV nebulae and planetary nebulae. Also, the effects of the stellar magnetic field are reviewed, and applied to the formation of elliptical and highly collimated planetary nebulae. Two-dimensional hydrodynamical and magneto-hydrodynamical simulations indicate that these processes are efficient in driving bipolar and collimated outflows.

We also discuss recent 3-dimensional, magneto-hydrodynamical simulations confirming that planetary nebula jets and ansae can be obtained by magnetic collimation of their central winds. Jets and ansae form at the polar regions due to the magnetic tension produced by the magnetized winds. It is proposed that the formation of "attached" and "detached" ansae involves two and three winds, respectively. It is shown that rotating jets and point-symmetric nebular shapes can be the result of a precessing star, tidally coupled with a companion.

To Appear in : The Sixth Texas-Mexico conference on Astrophysics, "Astrophysical Plasmas–Near and Far", RevMexAA, Serie de Conferencias, ed. R. Dufour & S Torres-Peimbert, in press

Preprints can be obtained by contacting ggs@astroscu.unam.mx
or via anonnymous ftp on kepler.astroscu.unam.mx, cd papers/ggs

Le Groupement de Recherches 968 "Milieux Circumstellaires" du CNRS,
l'Observatoire du Mont Megantic (Universite de Montreal, Quebec)
et l'Observatoire de Strasbourg (Universite L. Pasteur)
ont le plaisir de vous transmettre cette annonce d'Ecole Thematique :

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+       Ecoulements hypersoniques radiatifs hors equilibre :              +
+   applications astrophysiques (vents stellaires) et aerospatiales       +
+                                                                         +
+           Aspects theoriques, observationnels et numeriques             +
+-------------------------------------------------------------------------+
+   Ecole organisee au Mt.Sainte Odile (Bas-Rhin), du 22 au 25/09/97      +
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PROGRAMME ET PUBLIC:

La physique, la simulation et les tests experimentaux/observationnels des ecoulements hypersoniques radiatifs hors equilibre concernent aussi bien les astrophysiciens (vents stellaires, chocs, interactions dans les systemes binaires, etc.) que l'industrie aerospatiale (ecoulements autour de corps en mouvement rapide dans l'atmosphere de la Terre et bientot d'autres planetes). Les methodes de modelisation et de test astrophysiques ou industrielles ont des points forts et des points faibles, fort heureusement differents: l'experimentation apporte aux modeles des contraintes difficilement accessibles a l'astrophysicien, et l'astrophysique fournit un laboratoire de conditions extremes. Sous forme de cours et de conferences de synthese, les intervenants industriels et astrophysiciens, europeens et quebecois, rappelleront les fondements physiques des processus, leurs applications naturelles et artificielles, et ils lanceront le debat sur les problemes ouverts.

L'ecole s'adresse aux chercheurs, aux ingenieurs et aux etudiants doctorants ou de grande ecole de physique. Les orateurs sont invites a integrer a leur expose une mise a niveau des auditeurs des diverses communautes, afin de rendre possible l'acquisition d'un langage commun et de susciter des discussions. Celles-ci pourront se poursuivre au cours d'exposes informels et de tables rondes en soiree.

Les exposes seront essentiellement francophones, mais le recueil ecrit des cours sera publie en langue anglaise pour une plus grande diffusion.

COMITE SCIENTIFIQUE:
A. Acker (Observatoire de Strasbourg, France)
J.-P. J. Lafon (Observatoire de Paris, France)
A. Moffat (Universite de Montreal, Quebec, Canada)

PROGRAMME PRELIMINAIRE:

I- Ecoulements hypersoniques
 * Theorie (E.Huguet, Obs. de Paris-Meudon & R.Brun, CNRS Marseille)
 * Simulations numeriques (A.Vincent, CERCA Montreal & C.Marmignon, ONERA)
 * Applications spatiales (A.Broc, Obs. Paris-Meudon & L.Marraffat, ESTEC,ESA)

II- Vents stellaires, generalites
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 * Approche theorique (R.Kudritzki, Univ. de Munich, RFA)

III- Vents stellaires, instabilites et variabilites
 * Observations, theorie et simulations (A.Feldmeier, Univ. de Berlin, RFA)

IV- Vents stellaires, poussieres
 * Formation, chimie, nucleation (J.-P.J. Lafon, Obs. Paris-Meudon &
   N.Berruyer, OCA, Nice)

V- Vents dans les etoiles en formation
 * Vents stellaires (P.Bastien, Univ. de Montreal)
 * Vents et rotation rapide, disques (S.Owocki, Univ. Delaware)

VI- Vents d'etoiles evoluees et leur interaction avec le milieu interstellaire
 * Observations, etoiles peu massives et massives (A.Acker, Univ. de Strasbourg
   & N.St.-Louis, Univ. de Montreal)
 * Theorie et modelisation (G.Mellema, Univ. de Suede)

VII- Vents en collision dans les systemes binaires
 * Observations (A.Moffat, Univ. de Montreal)
 * Theorie (R.Walder, Univ. de Zurich, Suisse)

VIII- Table ronde : ou en sommes-nous ? (ecoulements hypersoniques radiatifs
   aux echelles galactiques : superbulles, jets, cheminees...)

EN PRATIQUE:

  Le site historique du Mont Sainte Odile se trouve a 765m d'altitude
a 40 km de Strasbourg, sur un premier sommet des Vosges d'ou il domine
la ville d'Ottrott et la plaine d'Alsace.
  L'ecole y debutera lundi 22 septembre a 15h et terminera le jeudi 25
a 16h. Un bus special quittera Strasbourg pour s'y rendre le lundi
vers 13h, et assurera le retour des participant jeudi apres-midi.
Le logement ainsi que les repas seront proposes sur place.

Les frais d'inscription, comprenant la pension complete, s'elevent a:
  ** 1200 F pour les participants chercheurs ou assimiles,
  ** 800 F pour les etudiants.
Un soutien financier peut dans certains cas etre obtenu.
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INFORMATIONS COMPLEMENTAIRES:

Une information complete est accessible au site suivant:
  http://astro.u-strasbg.fr/Obs/Colloques/GDR968/odile.html
  ou http://astro.u-strasbg.fr/~odile/colloque97.html
  ou http://www.obspm.fr/departement/dasgal/circumstellar.html

Le comite local d'organisation (A.Lancon, A.Acker, H.Baty, R.Monier,
S.Bulot, M.Michele, Observatoire de Strasbourg) sera
heureux de vous informer en repondant aux messages envoyes a:
   odile@astro.u-strasgb.fr