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Commission C27: Variable Stars†

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Abstract. We report the major highlights of variable star research within the past three years. This overview is limited to intrinsically variable stars, because the achievements in variable star research stemming from binarity, or multiplicity in general, is covered by the summary report of Commissions 26 and 42.

Keywords. Stars: Variables, Stars: Oscillations, Stars: Evolution, Stars: Fundamental Parameters, Techniques: Spectroscopic, Techniques: Photometric, Methods: Statistical

1. General Remarks on this Report

The Organizing Committee of C27 has decided, as in the previous two reports (in *Transactions, vol. XXIVA and XXVA*), to avoid an extensive bibliography here. Online availability of literature information, including review papers, is indeed excellent nowadays and needs no duplication. Hence the current report focuses on some highlights within variable star research over the past three years, as reported in the refereed literature. These highlights were selected after consultation with all the Commission members by email. We avoid work that is still in press, as well as work only orally communicated at conferences and not yet published. These achievements will be considered for the next triennial report covering the period 2005–2007. Further results besides those mentioned here can be found in numerous proceedings of conferences held in the time frame November 2002–August 2005 which are listed below, while references to proceedings of earlier meetings can be found in the previous report of C27 in *volume XXVA* of the *Transactions*. We also refer to the Information Bulletin on Variable Stars (IBVS) of Commissions 27 and 42 published by Konkoly Observatory in Hungary (see `http://www.konkoly.hu/IBVS/IBVS.html`) for further information. Finally, we draw the reader's attention to the new electronic editions of the General Catalogue of Variable Stars (GCVS) with improved coordinates for more than 10 000 variables (Samus *et al.* 2002, 2003).

The proceedings of IAU Symposium 215 "Stellar Rotation", held in November 2002, in Cancun, Mexico, were published by ASP in their symposium series (Eds. Maeder & Eenens, 2004). In December 2002 an International Workshop on "Stellar Candles for the Extra-galactic Distance Scale" was held in Concepción (Chile), where all variable stars traditionally used as distance indicators were reviewed (Eds. Alloin & Gieren, 2003). While the two very promising science cases, asteroseismology and exoplanet detection,

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† C27 has an operational email list and a informative web page available at: `http://www.konkoly.hu/IAUC27`. This web page has a facility to update email addresses. Members are strongly urged to make us of it in order to keep the email list up-to-date.

were intensively discussed during the Second Eddington Workshop "Stellar structure and habitable planet finding" held in April 2003 in Palermo, Italy (Eds. Favata, Aigrain & Wilson, 2004), the European Space Agency deleted the mission from its science programme for budgetary reasons in 2004. Variable stars in the Local Group constituted the theme of IAU Colloquium 193, held in July 2003 in Christchurch, New Zealand (Eds. Kurtz & Pollard, 2004), which took place just before the IAU GA of Sydney. During the latter, JD12 on "Solar and Solar-Like Oscillations: Insights and Challenges for the Sun and Stars" was held. One would have expected the year after the GA to be less densely populated with meetings on variable stars because the New Zealand meeting was attached to the GA. Noteworthy happenings, however, were IAU Symposium 224: "The A-Star Puzzle", held in Poprad, Slovakia in July 2004 (Eds. Zverko, Žižňovský, Adelman & Weiss, 2004), the SOHO 14/GONG 2004 Workshop "Helio- and Asteroseismology: Towards a Golden Future" which took place in July 2004 in New Haven, USA (Ed. Danesy, 2004) and the 14th European Workshop on White Dwarfs organized in Kiel, again in July 2004 (Eds. Koester & Moehler, 2005). The year 2005 saw several meetings with significant sessions on variable stars, of which the proceedings have not yet been published. We mention the "Second Meeting on Hot Subdwarf Stars and Related Objects", which was a focused workshop held in June 2005, La Palma, Canary Islands; the large international meeting "Stellar Pulsation and Evolution" held in June 2005 in Rome, Italy and finally the very recent meeting on "Active OB stars: Laboratories for stellar and circumstellar physics" which took place in September 2005 in Sapporo, Japan.

2. Long-period or Large-amplitude Variables

Classical oscillators remained a topic of intensive research. Large surveys and very long-term monitoring brought a new impetus to this domain several years ago. In addition, interferometric studies have come into play during the past two years.

Angular diameter measurements have become available for a large number of Cepheids and have led to high-precision calibrations of the surface brightness-color relations and accurate distances (Kervella *et al.* 2004).

The Harvard, OGLE and ASAS Databases of Galactic and SMC Cepheids have led to the deduction that almost all of the 1000 investigated stars are still pulsating in the same mode, i.e. none of them has crossed the instability strip. These surveys have shown that Cepheids with $\log P > 0.8$ days show significant period changes, but that these changes are smaller than those predicted by model calculations. Some observed targets turn out to have unusually long periods up to 210 days (Pietrukowicz 2002, 2003).

The first in-depth asteroseismic study of two classical Cepheids (OGLE SC3-360128 and SC5-338399 in the LMC), in which three subsequent radial overtones have been detected, imply that they must be crossing the instability strip for the first time and that their range in metallicity is limited to $Z \in [0.004, 0.007]$ (Moskalik & Dziembowski 2005). Evolutionary theory is challenged by the fact that these stars' derived period change is not in accordance with the observed ones. Moskalik *et al.* (2004) have further found non-radial modes in LMC overtone Cepheids, as well as periodic amplitude and/or phase modulation in LMC first- and second-overtone double-mode Cepheids, so that these stars may also become subject of seismic modeling in the near future. Interferometry has also been important in the interpretation of Mira stars. Perrin *et al.* (2004) deduced from their diameter measurements obtained with the IOTA instrument that all Mira stars are fundamental-mode pulsators. They find that previous studies leading to the conclusion of the first-overtone mode were biased by too large diameter estimates.

By assembling data over decades, Zijlstra *et al.* (2004) noted a drastic period increase of the Mira star BH Cru from 420 to 540 days, indicating an expanding radius and an accompanying amplitude increase. They also find evidence for this phenomenon in other Mira stars. They identify the cause as molecular opacity changes due to the presence of FeS in their outer atmosphere, which leads to an instability for stars with C/O ratio close to 1. Ever longer secondary periods of up to 1500 days are seen in data on Mira variables by Wood *et al.* (2004). The authors have tested numerous hypotheses to explain these secondary periods, such as eccentric motion of a low-mass orbiting companion, radial and non-radial pulsation, rotation of an ellipsoidal-shaped red giant, episodic dust ejection, star-spot cycles, etc. According to the authors, however, the most likely explanation for the observed chromosphere and the irregularity of the light curve is the occurrence of a low-degree gravity mode confined to the outer radiative layers of the star, combined with large-scale activity.

Jurcsik *et al.* (2002) re-examine the amplitude ratios of the photometric and radial velocity changes of Blazhko RRab stars in their different Blazhko phases. They find that none of the investigated stars has a normal RR Lyrae type light curve which highlights, once more, a lack of understanding of the Blazhko effect almost one century after its discovery. Connected to this, Cacciari *et al.* (2005) made a thorough study of the 32% of Blazhko stars among M3's RR Lyrae variables, and find them to appear erroneously more metal-rich if the metallicity is derived from the Fourier parameter ϕ_{31} which is based on the shape of the light curve. This argues against the use of the ϕ_{31} method to estimate the metallicity of the Blazhko variables. This conclusion is supported by the findings of Smolec (2005) who derived the metallicities of non-Blazhko and Blazhko variables, and found them to be close to each other from OGLE data on thousands of stars in the Galactic Bulge and the LMC.

The long-standing problem of the slope and zero-point of the absolute magnitude versus metallicity relation for the normal RR Lyrae stars, which has a strong impact on the definition of the distance scale, seems to be getting close to an answer. This is mostly based on accurate work on about 100 RR Lyrae variables in the LMC by Clementini *et al.* (2003) and Gratton *et al.* (2004). Their results point to a distance modulus for the LMC of 18.515 ± 0.085. Suggestions for non-linear calibrations of this relation have been presented both on theoretical and observational grounds, but need further study for a confirmation and better definition.

3. Stars with Activity

While more on stellar oscillations is reported below for different types of objects, solar-like rotational and cyclic variability due to magnetic activity continued to be an active research area in the past years and is treated here separately.

Messina & Guinan (2002) found activity cycles from long-term photometric data, rather than from the usual CaII H&K emission fluxes, for a sample of 6 young single G0-G5V stars with ages between 130 Myr and 700 Myr. They find faster-rotating stars to have longer cycles, and the level of magnetic activity appears to be controlled by the stellar rotation, even on the longest time scales. Moreover, Messina & Guinan (2003) studied the rotation of the same sample stars and found all stars to show variations of the rotational period. The authors interpreted this in terms of the existence of active latitude belts migrating during the activity cycle on a differentially rotating star, just as in the Sun.

Doppler images of individual, single active cool stars from high-resolution spectroscopy were continued to be made, e.g. by Kovari *et al.* (2004) and by Barnes *et al.* (2004, 2005) to mention just a few, leading to a variety of star-spot distributions at a range of latitudes. These studies suggest a trend in which differential rotation decreases with stellar mass in (pre-)main-sequence objects.

Another type of result was obtained by Messina *et al.* (2003), who studied the dependence of coronal X-ray emission on spot-induced brightness variations of different types of field and cluster cool main-sequence stars. The mean value of $L_x/L_{\rm bol}$ minus the maximum amplitude of the spot-induced brightness variations seems to decrease monotonically with increasing age, showing that, up to the Sun's age, the levels of photospheric and coronal activity evolve in time according to a single power law.

Enhanced X-ray emission from 4 M-type giants of small and intermediate mass that have evolved to the tip of the red giant branch, or are of the asymptotic giant branch, was explored by Hünsch *et al.* (2004). The origin of this higher-than-usual X-ray emission turned out to be an unusually high degree of magnetic activity, even though the stars are in an advanced evolutionary stage. Possible explanations might be the gain of angular momentum as a consequence of planet engulfment, or a remnant activity from previous evolutionary stages.

Finally, among the many studies of the variability of pre-main-sequence stars, we mention the recent one by Mohanty *et al.* (2005). These authors investigated disk accretion in objects ranging from just above the hydrogen-burning limit down to nearly planetary masses, and found that classical T Tauri-like disk accretion persists in the sub-stellar domain. A view on the particular case of the FU Orionis stars came from high-resolution spectroscopy of FU Ori itself and of V1057 Cyg between 1995 and 2002, which led Herbig *et al.* (2003) to derive a model with a rapidly rotating star near the edge of stability. The authors also considered the possibility that these stars are not ordinary T Tauri stars but may be confined to a special subspecies of rapidly rotating pre-main-sequence stars having powerful quasi-permanent winds. For the somewhat more massive Herbig Ae/Be stars, Dullemond *et al.* (2003) proposed that the variability time scales of weeks to months are caused by either flared or so-called "self-shadowed" disks. They tested these two disk models in a large sample of such stars. These two models are currently accepted as providing a good description for these pre-main-sequence star environments. As a last remark, short-period δ Scuti-type oscillations with frequencies near $70\,{\rm c\,d}^{-1}$ were reported for the Herbig Ae/Be stars HD 34282 (Amado *et al.* 2004). These high frequencies are interpreted as high radial order modes in stars near the blue edge of the instability strip, but require observational confirmation.

4. Solar-like Oscillations

The field of solar-like oscillators continued its growth during the past three years. While solar-like oscillations were confirmed from ground-based data in η Bootis (Kjeldsen *et al.* 2003, Carrier *et al.* 2005) and Procyon (Eggenberger *et al.* 2004a), new remarkable and unambiguous discoveries of such oscillations were made for the K1 dwarf companion α Cen B (Carrier & Bourban 2003) and the red giant star ξ Hya (Frandsen *et al.* 2002). The oscillation frequencies and mode lifetimes in α Cen A were much refined with VLT data (Bedding *et al.* 2005) while the modeling of α Cen AB was used to constrain the fundamental stellar parameters of this binary system with unprecedented detail (Eggenberger *et al.* 2004b; Miglio & Montalbán 2005). The oscillation spectrum of η Bootis was interpreted in terms of different equations of state and different core overshoot values by Di Mauro *et al.* (2004).

The asteroseismic community experienced a hiccup when the Canadian satellite MOST failed to detect p-mode oscillations in Procyon, a fact which was ascribed to the larger than anticipated granulation effects of the star by Matthews *et al.* (2004). However, the cause of this non-detection is still a matter of debate (Bedding *et al.* 2005). Meanwhile, MOST has firmly detected oscillations in different types of stars—see an example of a main-sequence O star below; results for a subdwarf B stars will be published in the near future (Randall, private communication). Analyses and interpretations of solar-like oscillations based on MOST data are also underway (Matthews, private communication).

A spectacular discovery of solar-like oscillations was made for the planet-hosting star μ Arae. Its acoustic spectrum, in which 43 frequencies have been found (Bouchy *et al.* 2005), was subjected to a seismic analysis (Bazot *et al.* 2005) in an attempt to decide whether its metal overabundance is primordial or due to accretion. Despite the very high quality of the HARPS data, the uncertainties are still too large to allow for a conclusive result.

Interferometry will also play a key role in seismology of sun-like stars, as the pioneering independent studies by Kervella *et al.* (2003) and Pijpers *et al.* (2003) point out. In both these studies, the authors determined the radius of nearby solar-like stars with unprecedented precision from VINCI/VLTI. Kervella *et al.* (2003) thus find the radius of Sirius A (A1V) to be $1.711 \pm 0.013\,R_\odot$ and Pijpers *et al.* (2003) derive $0.773 \pm 0.004\,R_\odot$ for the G8V star τ Ceti. Based on these results, the authors suggest these stars to be prime targets for asteroseismic campaigns. Following-up on this type of work, Thévenin *et al.* (2005) determined the angular diameter of the seismic targets α Eri, ξ Hya and τ Boo and confirm the observed mean large frequency spacing of these three stars.

5. A and F Star Variations

Research on δ Scuti stars included, among many other observational studies, a continuation of multi-site campaigns of some selected targets. As the most important case study, we mention the impressive results by Breger *et al.* (2005) for the star FG Vir. They have established 67 independent oscillation modes for this target in a frequency band from 5.7 to 44.3 c/d with amplitudes above 0.2 mmag and with evidence for additional low-amplitude modes. The large number of detected frequencies, as well as the large number of additional frequencies suggested by the power spectrum of the residuals, confirms the theoretical prediction of a large number of excited modes. The discovery of multiple modes of low amplitude in Altair from the WIRE satellite (Buzasi *et al.* 2005) also seems to reveal that many of the stars so far considered as constant within the instability strip exhibit oscillations, and that the ratio of pulsators versus constant stars will change drastically once high-precision space measurements will be available for large samples, e.g. from the future COROT space mission up for launch in August 2006. Ground-based preparations for the COROT mission have revealed, by the way, several new relatively bright variable stars in the instability strip, both in the direction of the Galactic Center and Anticenter (Poretti *et al.* 2003, 2005).

On the theoretical side, the papers by Dupret *et al.* (2005a,b) caught our attention, as they present for the first time the application of a time-dependent convection treatment which is able to explain both the stabilization of p-modes of δ Scuti stars at the red edge of the instability strip and the driving of the g-modes in the cooler γ Dor stars by convective blocking. Also, their theory predicts the existence of hybrid stars with both p-mode and g-mode oscillations. Handler & Shobbrook (2002), however, have shown statistically that γ Dor stars are less likely to be p-mode pulsators compared with other normal stars in the same region of the lower instability strip. The discovery by Henry & Fekel (2005) of p- and g-mode pulsations in the Am metallic-line star HD 8801 is remarkable in this respect. The star HD 209295 is also a hybrid δ Scuti–γ Dor star, but its oscillations are probably tidally driven (Handler *et al.* 2002).

The past triennium in general saw a vast increase in our observational knowledge of the γ Dor stars. Henry & Fekel (2002, 2003) and Henry *et al.* (2005) discovered 29 new class members altogether, while Mathias *et al.* (2004) reported on a large multi-site, multi-technique 2-year campaign on γ Dor (candidate) stars, revealing line-profile variations in more than half of their targets. Empirical mode identifications for γ Dor stars are scarce because most discovery papers are based on single-filter photometry. Moya *et al.* (2005) have devised a method, termed the Frequency Ratio Method, for obtaining asteroseismological information from high-order g-mode oscillators and applied it to the γ Doradus star HD 12901. Their results agree with empirical mode identification available for this star. This method, based on the ratios of observed frequencies, constitutes a promising tool for the seismic modeling of slowly and moderately rotating γ Dor stars, as current work points out (Suárez, private communication).

The study of roAp stars has changed drastically over the past few years, with photometric studies being overtaken by high spectral resolution, high time resolution spectroscopic studies. These are being vigorously carried out by several groups who are beginning to resolve the pulsation structure in roAp stars in 3-D. These novel observations resolve the pulsation as a function of atmospheric depth, using the abundance stratification of certain ions to determine pulsation amplitude and phase in the range $-5 \leqslant \tau_{5000} \leqslant 0$, and even higher into the atmosphere. Some examples are the high resolution studies of 33 Lib by Mkrtichian *et al.* (2003) and of HD 166473 by Kurtz *et al.* (2005), the latter using very precise data from VLT/UVES. A second aspect in roAp research was the attempt to understand the differences between roAp and noAp stars by the computation of a theoretical instability strip (Cunha 2002) and by comparing the spectroscopic differences between ro and noAp stars (Ryabchikova *et al.* 2004). Very recently, intermediate-period roAp stars were found using VLT data (Elkin *et al.* 2005), which will help to detail the instability computations further. Moreover, Saio (2005) has shown that the direct effect of the magnetic field on the oscillations contributes to the stabilization of the low-order modes in roAp stars. Finally, it remains to be seen what the impact will be of the new version of the so-called oblique pulsator model by Bigot & Dziembowski (2002). In this model, the combined effect of rotation and magnetic field was taken into account allowing for oscillations not aligned with the magnetic field axis. This model has not yet been used to interpret the splendid new high-quality spectroscopic data quantitatively. In this respect we refer to Kochukhov (2004), who made an “image” of the pulsation velocity field from time series observations of spectra for the roAp star HR 3831 and showed that the oscillations of this star *do* seem to be aligned with the axis of the global magnetic field.

6. B Star Research

As already mentioned in our previous report (*Transactions, vol. XXVA*), the study of the massive pulsating main-sequence B stars is no longer limited to our Galaxy since the discovery of β Cephei stars in the LMC (Pigulski & Kołaczkowski 2002). Notwithstanding this exciting and important result, new class members also remain to be found in the Galaxy, e.g. from large general surveys (Pigulski 2005) or from dedicated campaigns for young open clusters (Kołaczkowski *et al.* 2004 and references therein to previous campaigns).

Otherwise, selected β Cephei stars have become the target of huge dedicated ground-based campaigns. On the basis of one such multicolor single-site campaign for the star

HD 129929, which lasted 21 years, Aerts *et al.* (2003) established the occurrence of non-rigid rotation for the star, with the core spinning four times faster than the surface. A similar result was obtained by Pamyatnykh *et al.* (2004) for the star ν Eri, which was the target of the largest multi-site multi-technique campaign ever organized (see Jerzykiewicz *et al.* 2005 and references therein). As shown by Pamyatnykh *et al.* (2004) and Ausseloos *et al.* (2004), standard stellar models are unable to explain ν Eri's behavior and this led Pamyatnykh *et al.* (2004) to suggest that diffusion processes must be included in the models to solve the excitation problem for some of ν Eri's modes. We are still awaiting more explicit non-standard models to see if they can indeed resolve the discrepancies between theory and observations. Meanwhile, additional large campaigns have been organized for 12 Lac, 16 Lac and V2052 Oph and the results are on their way (Handler, private communication).

Some β Cephei stars have been observed from space with the WIRE satellite (e.g. Cuypers *et al.* 2002), while the MOST mission has revealed a dozen β Cephei-like p-mode frequencies for the rapidly rotating O9.5Ve star ζ Oph (Walker *et al.* 2005) from a 24-day campaign. This subject is related to the currently rather intensive debate on the closeness to critical rotation of Be stars, with ζ Oph having one of the highest measured rotational velocities known. Domiciano di Souza *et al.* (2003) derived an impressive result from interferometry for the Be star Achernar (α Eri) which seems to have a difference in equatorial versus polar radius by a factor of 1.6. Townsend *et al.* (2004) argue from line-profile simulations that observational studies have paid insufficient attention to the effects of equatorial gravity darkening in deriving equatorial rotation velocities of Be stars; they suggest that these stars may be rotating much closer to their critical velocities than is generally supposed. This would be of high relevance to the unraveling of the mechanism responsible for the circumstellar disks of Be stars. Rivinius *et al.* (2003), on the other hand, provided evidence for non-radial oscillations in a sample of 27 early-type Be stars and suggested that multi-mode beating may be responsible for the formation of their circumstellar disks. Both suggestions are not incompatible with each other, of course. For a summary of results on active B Stars we refer to the future proceedings of the Sapporo meeting, which will appear in 2006.

The slowly pulsating B stars, while potentially very interesting targets for asteroseismology because of their high-order g-modes, remain observationally challenging objects. This is because of their long individual oscillation periods (on the order of days), leading to beat periods of months to years (much like for the γ Dor stars). Moreover, their rotation periods are of the same order of magnitude than their oscillation periods, so the Coriolis force cannot be ignored in the theoretical treatment of their oscillations (Townsend 2003). Despite these difficulties, progress on mode identification in these stars was reported by De Cat *et al.* (2005). These authors combined three types of state-of-the-art identification methods and applied them to long-term multicolor photometry and high-resolution spectroscopy and found $\ell = 1$ sectoral modes for all modes in all targets with unambiguous identifications. Is it a coincidence that this result is similar to the one found for the γ Dor stars, which are the other high-order g-mode main-sequence pulsators?

7. Compact Oscillators

While oscillation studies of individual white dwarfs are quite mature compared to those of the less evolved objects, Mukadam *et al.* (2004) almost doubled the number of known ZZ Ceti stars with their discovery of 35 new members of that class of pulsating DA white dwarfs. They made their discovery among objects from the Sloan Digital Sky Survey and the Hamburg Quasar Survey. Similar follow-up studies resulted in an additional 11 new ZZ Ceti stars (Mullally *et al.* 2005) bringing the total number of published variable DA white dwarf stars to 82. Additional searches are currently ongoing (Kepler, private communication). Gianninas *et al.* (2005) subsequently presented an empirically determined ZZ Ceti instability strip, with a well constrained red edge but a rather large range of possibilities for the slope of the blue edge. Their empirical ZZ Ceti instability strip contains no non-variable white dwarfs. For one particular class member of the ZZ Ceti stars, BPM 37093, it was shown that constraints on crystallization of the interior can be obtained (Kanaan *et al.* 2005; Metcalfe *et al.* 2004). Brassard & Fontaine (2005), however, question the feasibility and application of this seismic technique to DA white dwarfs.

A summary of various interior structure models for DB white dwarfs was presented by Metcalfe (2005), who incorporated C/O profiles into double-layered envelope models of such stars. The testing of crystallization and diffusion theory from asteroseismology of white dwarfs will surely be further explored in the near future.

Woudt & Warner (2004) reported the discovery of a second pulsating white dwarf in a cataclysmic variable from the Sloan Digital Sky Survey, with at least four pulsation periods. This object may become highly interesting for seismic investigations. Another interesting suggestion is the occurrence of non-radial oscillations in symbiotic stars (Bondar & Prokoféva, 2005). The authors suggest that the interaction between gas flows and the accretion disk may constitute a possible excitation mechanism in these objects.

Asteroseismology of subdwarf B (sdB) stars has gained in interest, particularly since the late stages of evolution of close binary stars is not yet well understood and it was realized that pulsating sdB stars are laboratories to test the current scenarios, e.g. those computed by Han *et al.* (2003). The pulsating sdB stars were discovered in 1997 and have recently been studied intensively in high-precision multicolor photometry (Jeffery *et al.* 2004, 2005) and spectroscopy (O'Toole *et al.* 2003). Detailed asteroseismic analyses have been reported for only two pulsating sdBs, however, namely PG 0014+067 (Charpinet *et al.* 2005a) and PG 1219+534 (Charpinet *et al.* 2005b), stars with 16 and 12 identified frequencies, respectively. This high number of observed frequencies requires either high values of spherical degree $\ell > 2$ (Charpinet *et al.* 2005a) or splitting of the frequencies through a rapidly rotating core (Kawaler & Hostler 2005).

Green *et al.* (2003) discovered a new class of pulsating sdB stars having long-period g-mode oscillations. These stars have been termed "Betsy stars" within the asteroseismic community ever since she announced her discovery at the international meeting "Asteroseismology across the HR-diagram" held in Porto in July 2002. In-depth asteroseismic studies are difficult because of their complex and mostly unresolved multi-periodic oscillations and long periods (between 0.8 and 1.4 hours for the class prototype PG 1716+426, Reed *et al.* 2004). The relation between p- and g-mode sdB pulsators is remarkably similar to the one between the pulsating main-sequence β Cephei stars and slowly pulsating B stars (Fontaine *et al.* 2003). Baran *et al.* (2005) recently found an sdB star pulsating simultaneously in p-modes and in g-modes. Thus there is clearly a link between these two groups of pulsating sdB stars and such hybrid objects as Balloon 090100001 are ideal for future seismic modeling.

8. Working Groups

Finally, we wish to remind the reader about the three working groups which are operational under auspices of, among others, Commission 27:

(*a*) The Working Group on Active B Stars, whose activities and electronic newsletter can be found on `http://www.astro.virginia.edu/~dam3ma/benews/iauwg_abs.html` (*b*) The Working Group on Ap and Related Stars, whose activities and electronic newsletter can be found on `http://www.eso.org/gen-fac/pubs/apn/apwg/`

(*c*) The Working Group for Spectroscopic Data Archives whose webpage is available from `http://www.konkoly.hu/SVO/`

Conny Aerts,
President of the Commission,
on behalf of the OC and the
commission members

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