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**A PROPOSED UNIFORM NOMENCLATURE FOR PULSATING
HOT SUBDWARF STARS**

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The first rapidly-pulsating sdB stars were found accidentally in the mid-1990s (Kilkenny et al., 1997 and following papers). At the same time – and independently – the Montreal group was showing that these stars should pulsate (see the review by Charpinet et al., 2001). Over 40 such stars are now known; they are *p*-mode pulsators with periods $\sim 2 - 5$ minutes, though periods as long as 9 minutes are known. They can exhibit anywhere from one to over 40 pulsation modes and occur amongst the hotter sdB stars with $28000 < T_{\text{eff}} < 35000$ and $5.2 < \log g < 6.1$.

The slowly-pulsating sdB stars were also discovered serendipitously during a search for sdB binaries by looking for eclipses, ellipsoidal and reflection effects (Green et al., 2003). Over 30 slow pulsators are now known, though it is possible that a large fraction of the cooler sdB stars might pulsate. They are *g*-mode pulsators and typically have periods $\sim 1 - 2$ hours. Like the rapid pulsators, they are multi-periodic but occur amongst sdB stars with $T_{\text{eff}} < 27000$ and $\log g \sim 5.4$, and there appears to be a good separation between the rapidly- and slowly-pulsating sdBs in a $T_{\text{eff}}/\log g$ diagram (see Fig. 3 in Schuh et al., 2006, for example).

An exciting discovery was that some sdB stars exhibit *both p*- and *g*-mode pulsations (Schuh et al., 2005; Oreiro et al., 2005). The oddly-named Balloon 090100001 exhibits many modes; Baran et al. (2009) recently listed 73 *p*-modes in the range $2800 - 5500 \mu\text{Hz}$, 24 *g*-modes in the range $100 - 400 \mu\text{Hz}$, and 17 combination frequencies. A handful of these stars are now known and all lie on the temperature boundary between rapidly- and slowly- pulsating stars.

The first (and only known) variable helium-rich sdB star, LSIV-14°116, was found by Ahmad & Jeffery (2005). From the discovery observations, these authors find two periods – 1950s and 2900s (amplitudes ~ 0.004 mag) – and suggest that these are *g*-modes. This

is in accord with the long periods, but the star has $T_{\text{eff}} = 32500$ K which puts it in the rapidly-pulsating zone (for normal sdB stars). However, recent sdB models indicate that g -modes should be stable at this temperature (Fontaine et al., 2003).

Most recently, the discovery was announced of the first (and only known) pulsating sdO star, SDSS J160043.6+074802.9 (Woudt et al., 2006). Variability was discovered (again serendipitously) during a search for new AM CVn stars amongst Sloan Digital Sky Survey stars of appropriate colour. This star shows a strong 2 minute oscillation (of large amplitude ~ 0.04 mag) with a clear first harmonic near 1 minute. Woudt et al. (2006) find at least another 8 frequencies between the main oscillation and its harmonic and show that, spectroscopically, the star is a classical sdO star.

The relatively rapid discovery of a new genus – the pulsating hot subdwarfs – comprising several species, sdB (slow, fast and “hybrid”), He-sdB and sdO – has resulted in a confusion over nomenclature. The rapidly-pulsating sdB stars have been widely referred to as “EC14026 stars” after the prototype, and “sdBV stars”; the compilers of the General Catalogue of Variable Stars tentatively labeled them “RPHS” (very rapidly pulsating hot (subdwarf B) stars) but that name was never used – and the GCVS had already asked for suggestions for a better designation (Kazarovets, Samus & Durlevich, 2000). The slowly-pulsating stars have been called “PG1716 stars” after the prototype, or “Betsy stars” after the discoverer, Dr. Elizabeth M. Green, and also “lpsdBV” stars – where the “long-period” (lp) serves to separate these objects from the (rapidly-pulsating) sdBV stars. The sdB stars which show both rapid and slow pulsations – all fairly recent discoveries – have been widely referred to as “hybrid” pulsators. There is no clearly standardised nomenclature and this lack was raised for discussion at the Vienna pulsation meeting (Kilkenny, 2007) and the third and fourth meetings on pulsating hot subdwarfs (Fontaine et al., 2008; Kilkenny, 2009).

Table 1 summarises the problem and suggests a solution. It is common usage in variable star research to use “prototype” names – Cepheids, Miras, δ Scuti stars, and so on. In some cases, these are also the prototype *variable* star name – RR Lyrae stars, for example. Using prototype names for the hot subdwarf variables would, in some cases, be terribly unwieldy (e.g. “SDSS J160043.6+074802.6 stars”) and prototype variable star names are less easy to remember in the cases of these late arrivals on the variable star stage (e.g. “V1093 Her stars”). The informal names (“EC14026” and “Betsy” stars) have been a pleasant way of linking the stars to their discoverers but perhaps should now be replaced by a more systematic nomenclature.

By analogy with the white dwarf stars (DAV, DBV, etc.), we suggest that the simplest expedient is to add “V” to the spectral designation to indicate a *photometric* variability. One problem is that we have effectively three different types of pulsators within the sdB class. It is here suggested that we add the subscripts “r”, “s” or “rs” – for rapid, slow and hybrid pulsators. The subscripts need not be added to the He-sdBV or sdOV designations unless new discoveries make this useful. (We suggest subscripts, rather than straightforward letters because these qualify the “V” designation, rather than the spectral type).

The use of “r” and “s” is, perhaps, not optimum; “fast” is a more direct antonym of “slow” than “rapid” – and “s” could be misinterpreted as short (period) rather than slow (pulsation). But the usage suggested in Table 1 already exists in variable star nomenclature in the form of the rapidly-oscillating Ap stars (roAp) and the slowly-pulsating B

stars (spB) and is therefore more appropriate.

Table 1. Photometrically variable Subdwarf Types.

Pulsator Type	Prototype Name		Variable Star Name	Informal Usage	Proposed Nomenclature
sdB (rapid) (<i>p</i> -mode)	EC 14026-2647	=	V361 Hya	EC14026 sdBV	sdBV _r
sdB (slow) (<i>g</i> -mode)	PG 1716+426	=	V1093 Her	PG1716 “Betsy” lpsdBV	sdBV _s
sdB (both) (<i>p</i> and <i>g</i>)	HS 0702+6043	=	DW Lyn	“Hybrid”	sdBV _{rs}
He-sdB (<i>g</i> -mode ?)	LSIV -14°116				He-sdBV
sdO (<i>p</i> -mode)	SDSS J160043.6+074802.9				sdOV

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