that the nucleus of NGC 5548 contains two supermassive objects, each with its own associated broad-line region. If these are components of a binary system, estimates of the period and size of the system can be made from the absence of changes in the wavelength of peak emission from the blueward component. This leads to a mass estimate which is consistent with masses expected in active galaxy nuclei (specifically, $4.5 \times 10^8 M_\odot$ for this system). Ironically, it changes in the peak wavelength of the blue component which will allow a definitive test of this hypothesis.

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57.08
Optical Spectra of Narrow Emission-Line PG Galaxies and of CSO 177
D.E. Osterbrock, R.W. Pogge (Lick/UCSC)

In the Schmidt and Green PG catalogue of blue "stellar" objects, including especially QSO candidates, are listed 36 galaxies with narrow emission lines, which are thus possible Seyfert 2 galaxies. Of these three are in fact previously published as Seyfert 1 or 1.5 galaxies with broad H I emission lines, and one more, PG 1111 + 099 = Mrk 732 is a new Seyfert 1.5. Another, PG 1426 + 285 = Mrk 884 is a narrow-line Seyfert 1 of the type described by us in a previous paper, while still another, PG 1016 + 336 is also a Seyfert 1 with only slightly broader H II lines, similar to those in 1 Zw 1. Nearly all the remainder are high-ionization H II region galaxies, in which gas is ionized by numerous hot OB stars. Only one, PG 2259 + 157 = Mrk 313 is a Seyfert 2 galaxy. Thus the number of high-luminosity Seyfert 2's blue enough to be included in the PG survey, is quite small, as expected from previous color and spectral information. Also, our spectra of CSO 177, another high-luminosity narrow emission-line galaxy with $z = 0.116$ (Zotov, 1985), extend to the [N II], [O I], [S II] region and show it to be an H II region galaxy rather than a Seyfert 2.

Session 58: Stellar Spectra/Atmospheres II
10:15–12:15 (Room C-112)

58.01
Stellar Granulation: Photospheric Line Asymmetries and Hydrodynamic Model Atmospheres
D. Dravins (Lund Observatory, Sweden)
A. Nordlund (Copenhagen University Observatory, Denmark)

Effects of stellar surface convection (the stellar equivalent of solar granulation) are visible in integrated starlight as slight asymmetries and wavelength shifts in photospheric absorption lines. Such asymmetries arise due to unequal photon contributions from hot, rising and blueshifted elements, and cool, sinking and redshifted ones. Since these asymmetries are typically only some percent of the linewidth, their observation requires very high spectral quality. Using the ESO coude echelle spectrometer in a double-pass scanner mode at $\lambda / \Delta \lambda = 200,000$, photospheric line asymmetries have been mapped for several stars, including a G2 A (G2 V), Procyon (F5 V V-V), Arcturus (K1 I I), and Canopus (F0 II), revealing considerable differences among various spectral types.

Numerical supercomputer simulations of the time-dependent, radiation-coupled, three-dimensional hydrodynamics of stellar surface convection have been carried out in the temperature range 5200 – 6600 K. The resulting time sequences show the evolution of granules on stellar surfaces, and disclose the nature of convection beneath the visible layers. The models contain only three adjustable physical parameters: effective temperature, surface gravity, and chemical abundances. Using the computed atmospheric structure as a set of spatially and temporally varying model atmospheres, synthetic spectral lines (including asymmetries and wavelength shifts) have been obtained as averages over the simulation sequences. The results show a considerable agreement with observations, and further predict convective blueshifts (apparent radial velocities) in the range 200–1000 m/s, strongly varying with stellar temperature, thus underlining the significance of stellar granulation also for accurate radial velocity studies.

* Based on observations collected at ESO, La Silla, Chile.

58.02
Efficiency of Flux Tube Wave Generation in Late Type Stars
Z.E. Musielak (NASA/MSFC), R. Rosner (Ctr. for Astrophysics), P. Ulaschneider (U. Heidelberg), H.U. Bohn (U. Wurzburg)

We consider the generation of longitudinal and transverse tube waves in the outer convective zone of late-type stars. We assume that, as in the Sun, thin flux tubes embedded in the convective zone are subject to turbulent fluid motions outside the tubes, leading to tube wave generation and propagation. Theoretical expressions for the consequent wave energy fluxes are given as a function of wave frequency, multipole coefficients and flux tube parameters for the simplest case of vertically-oriented flux tubes. We show that although both comparable and inaccessible tube waves are generated (mainly by monopole emission), the generation efficiency is a strong function of the type of wave considered: the generation efficiency for longitudinal tube waves is much higher. We present energy flux calculations for both the Sun and late-type stars; compare them to those obtained previously for the magnetic field-free and the homogeneous magnetic field cases; and show that the efficiency of tube wave generation significantly exceeds that for both acoustic and classical MHD waves. These results are directly relevant to the problem of explaining UV and soft X-ray observations of late-type stars, which were thought to be in conflict with the theory of coronal heating by purely acoustic (e.g., non-MHD) waves.

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