

## Star Formation in Seyfert Bulges

Mark Whittle

*Astronomy, University of Virginia, Charlottesville, VA 22903, USA*

Charles H. Nelson

*Physics & Astronomy, Drake University, Des Moines, IA 50311, USA*

**Abstract.** We use measurements of the Mg b and Ca II triplet absorption line strengths to investigate the nature of the UV/optical continuum in Seyfert galaxies. A number of lines of evidence point to the presence of a young stellar population in the nuclear regions of many Seyferts.

### 1. Introduction and Observations

The origin of the nuclear continuum light in Seyferts has received much attention over the years. An early consensus favoured a simple combination of an old bulge population and a point-like AGN component, probably a featureless power law (or closely related components such as scattered nuclear light and/or nebular continuum). However, a number of studies (including many by Roberto and his collaborators) have pointed to the importance of a younger stellar component.

In this contribution, we investigate these possible continuum components using measurements of nuclear and off-nuclear equivalent widths of the Mg b and Ca II triplet (Ca T) absorption features at  $\sim 4481\text{\AA}$  and  $\sim 8500\text{\AA}$ . Our sample includes  $\sim 80$  Seyferts which were observed principally to obtain stellar velocity dispersion,  $\sigma_*$  (Nelson & Whittle 1995). Although the sample is not rigorously defined, nor were both features measured for every galaxy, nonetheless the sample is large enough to identify important trends and exclude certain possibilities.

### 2. Results

We use the Mg b and Ca T strengths, together with  $L(\text{H}\beta)$  and  $\sigma_*$  to investigate a number of diagnostic relations.

(a) Seyferts do *not* follow the well known correlation between Mg b strength and  $\sigma_*$  for spheroids (ellipticals and bulges) — many have weak Mg b despite having deep central potentials.

(b) The degree to which a Seyfert falls away from this relationship is strongly correlated with its  $\text{H}\beta$  luminosity (more luminous Seyferts have weaker Mg b). Apparently, the Mg b spectral region is diluted by a ‘featureless’ component

whose relative contribution depends on  $L(H\beta)$ . This relation is shown in Figure 1.

(c) We explore three models to account for this data (see Figure 1 caption for details). (i) An old bulge population diluted by a power law AGN component whose strength scales with  $L(H\beta)$ . Although this tracks the upper envelope of the data, clearly many Seyferts have much weaker Mg b than their modest  $H\beta$  strengths imply. (ii) An old bulge population plus an evolving starburst. Although such models span the data, by themselves they do not, of course, yield the appropriate emission line spectrum. (iii) Adding both starburst and AGN (scaled by  $L(H\beta)$ ) to an old bulge population also spans the data. Importantly, models exist which can simultaneously reproduce weak Mg b while maintaining the characteristic Seyfert emission line spectrum.

(d) Using long slit data we find a strong correlation between nuclear and off-nuclear Mg b strengths. Specifically, many Seyferts with weak nuclear Mg b *also* have weak off-nuclear Mg b, suggesting that the diluting continuum source is extended by at least a few arcseconds. A few Seyfert 1s do, however, follow the expected trend of stronger off-nuclear Mg b, consistent with a point-like continuum source.

(e) Figure 2 compares the nuclear Mg b and Ca T strengths. Clearly, Ca T can be strong regardless of the Mg b strength. Once again, models which include only an AGN power law fail to reproduce the trend. However, the contribution from red supergiants in an evolving starburst can yield simultaneously strong Ca T and weak Mg b, as was first noted by Terlevich, Diaz & Terlevich (1990).

(f) Finally, we find that the objects with the strongest evidence for a starburst contribution (weak Mg b; strong Ca T) also have far-IR colors which more closely resemble those of starburst galaxies. Conversely, those objects with little evidence for a starburst contribution (strong Mg b or weak Mg b and weak Ca T) have far-IR colors typical of AGN.

### 3. Conclusions

Several lines of evidence suggest that the original picture of Seyfert spectra comprising a point source power law superposed on a old bulge population is no longer valid. Models of that kind fail to reproduce the combinations of (1) weak Mg b with strong  $H\beta$ , (2) weak nuclear and off-nuclear Mg b, (3) weak Mg b with strong Ca T. Models which introduce an evolving starburst can reproduce all these features, without necessarily undermining the high excitation nature of the emission line spectra. The frequency of these features suggests that young stellar populations are present in many if not all Seyfert nuclei.

### References

- Nelson, C.H. & Whittle, M. 1995, ApJS 99, 67  
 Terlevich, E. Diaz, A.I., & Terlevich, R. 1990, MNRAS 242, 271

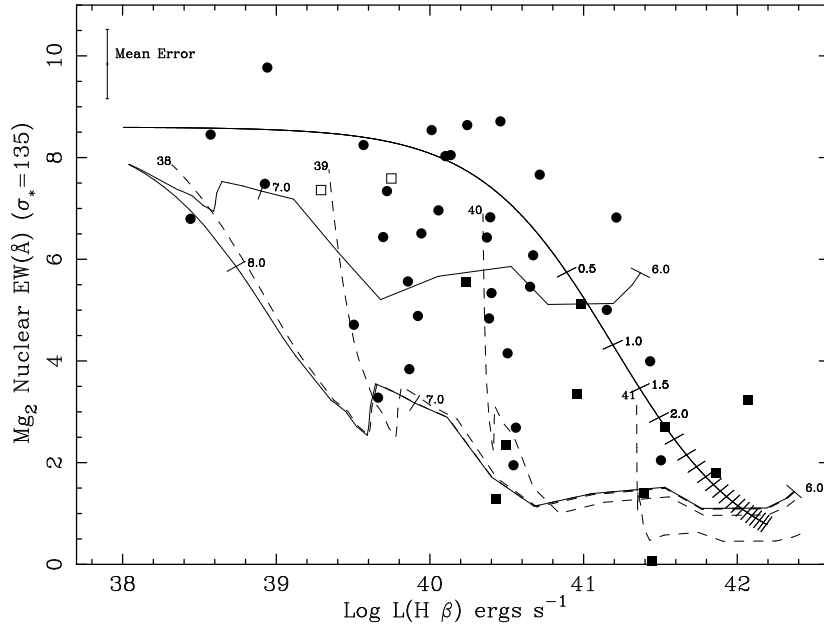


Figure 1.  $L(H\beta)$  vs  $Mg\ b$  (corrected to  $\sigma_* = 135 \text{ km s}^{-1}$ ). Smooth line : old population plus power law which scales with  $L(H\beta)$ . Ticks give  $L_{PL}/L_{bul}$ . Jagged lines : old pop plus evolving starburst (SB99) marked in log age, for initial  $L_{SB}/L_{bul} = 5$  (lower) and  $0.5$  (upper). Dashed lines : old pop plus starburst plus power law scaled by  $L(H\beta)$ .

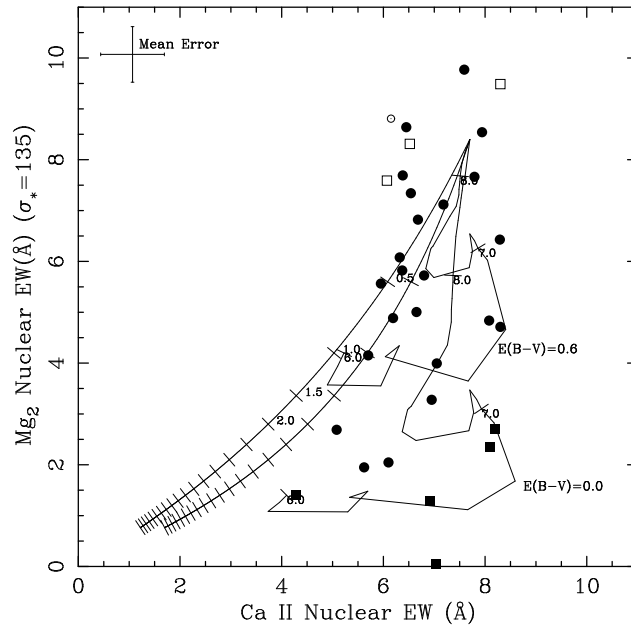


Figure 2.  $Mg\ b$  vs  $Ca\ T$ . Smooth lines : old population plus power law with slopes  $\alpha = 1$  and  $0.2$ . Jagged line : evolving starburst with  $E(B-V) = 0.0$  (lower) and  $0.6$  (upper). Tick marks as in Figure 1.