A Massive Star Odyssey, from Main Sequence to Supernova
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Ultraviolet spectra of star-forming galaxies with time-dependent dust obscuration

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Abstract. We present a new approach to probe the properties of the most massive, ionizing stars with respect to the less massive, non-ionizing stars. The new technique utilizes stellar-wind lines, instead of the previously employed nebular lines. This allows us to probe the timescale of the dust dispersal in a very young obscured starburst from purely stellar diagnostics.

1. Introduction

There is empirical evidence for different reddening of the stellar continuum in the UV and the gaseous emission in the visual. The later has a reddening almost twice as that of the former. Two alternative explanations have been suggested: Calzetti (1997) favors a different spatial distribution of the UV-bright stars and the ionized gas. In this picture, the newly formed stars in any mass range have lower dust obscuration than the gas since stellar winds have swept away gas and dust from the birthplace early in the star-formation episode. Alternatively, Charlot & Fall (2000) proposed that stars and gas are spatially coincident over the size of the starburst, but have a cloud-like substructure. Here, the higher reddening seen in emission lines results from the larger dust attenuation of the ionizing stars still embedded in their birth clouds. Subsequently, the birth clouds disperse, and less massive stars exhibit a less reddened UV continuum.

We propose an alternative observational test to distinguish the two interpretations. The key is not to combine both stellar and nebular diagnostics, which confuses the issue. The idea is to use stellar-wind features in the UV, that are not affected by assumptions on the gas.

2. Dust sensitive spectral lines and the synthetic UV spectra

Our goal is to identify stellar emission and absorption lines which originate from stars of different mass than those seen in the adjacent continuum. We restrict our discussion to young stellar populations with ages of order 10^8 yr or less. The corresponding stellar spectral types that contribute to the integrated spectrum are OB stars in the UV to optical, and late-type supergiants in the red/IR part of the spectrum.

Evolved and unevolved stars have comparable luminosities in the blue part of the H-R diagram. Then the integrated spectrum of a population with OB stars being dominant should display the effect we are looking for.

The strongest lines in OB stars originate in powerful stellar winds. These lines relative to the continuum should be very sensitive, *e.g.*, to age and IMF. This implies that dust obscuration effects will affect these lines as well. Given this situation, we find the O-star wind lines in the UV as the best — and the only — stellar lines which allow us to probe obscuration effects with purely stellar diagnostics.

A parameter study with STARBURTS99 (Leitherer *et al.* 1999) demonstrates, that the emission part of the wind lines can be weakened or strengthened with respect to the surrounding UV continuum for an increased or decreased strength of the O-type star population, relative to older, less massive B-type stars. The same holds for the absorption part of the profile, but this aspect is less useful in typical galaxy spectra, due to contamination by interstellar absorption. C IV λ1550 is best suited for this method, due to its intrinsic strength and the dominant dependence on spectral type, and therefore mass and age.

UV line-profile variations are not unique evidence for or against time dependent dust obscuration. One can always trade off dust obscuration for IMF variations or time-dependent star formation.

3. Conclusions

We have presented a new approach to probe the properties of the most massive, ioninzing stars with respect to the less massive, non-ionizing stars.

We found that time-dependent dust obscuration, which attenuates the UV light from ionizing stars more than that from non-ionizing stars, produces a significant dilution of the C IV λ1550 profile. This effect can be a powerful diagnostic to distinguish between alternative models for the dust morphology in star-forming galaxies. Otherwise the strength of the C IV emission could be understood if non-standard and less plausible assumptions on the IMF or the star-formation history were made. Higher-quality data are needed for a fully conclusive answer. A more complete analysis can be seen in Leitherer *et al.* (2002).

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