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# Strategies for flux calibration in massive spectroscopic surveys

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**Abstract.** Optical large-scale medium-resolution spectroscopic surveys such as SDSS, LAMOST, DESI, WEAVE or 4MOST are subject to constraints that limit the choice of flux calibrators, and the attained precision. The use of optical fibers, a large but limited field of view, the tiling strategies and tight schedules, are all factors that call for a careful evaluation of the flux calibration procedures.

The density of stars with well-known spectral energy distributions is so low that makes them unsuitable for flux calibration of large scale spectroscopic surveys. The alternative is to use stars with relatively simple spectra, which can be approximated well by synthetic spectra based on model atmospheres. One example are white dwarfs (Bohlin 1996), but their density is also too low for practical purposes: a few per square degree down to 19th magnitude. An alternative choice, exploited by the SDSS, are halo turn-off F-type stars (Stoughton *et al.* 2002). A-type stars offer another option, albeit with lower densities at high Galactic latitudes (Allende Prieto & del Burgo 2016). Ideally, one would use stars of various spectral types. The most common type, halo turn-off stars, can be used for the actual calibration, and the others for quality assessment.

The spectral typing needs to be performed before spectra are flux calibrated. Our group has explored various strategies for continuum normalization (the removal of the instrument response), finding good results using a running mean filter (Aguado *et al.* 2017; Allende Prieto *et al.* 2014). Interpolation in the models speeds up the model fitting process, but it is important to ensure that interpolations are sufficiently accurate (see, e.g. Mészáros & Allende Prieto 2013).

Fiber-fed spectrographs are particularly challenging, since errors in positioning fibers, guiding errors, or differential atmospheric refraction, add up. In our tests with data from the Baryonic Oscillations Spectroscopic Survey (BOSS; Dawson *et al.* 2016), we conclude that while the flux calibration is statistically accurate ($< 5\%$), individual spectra can exhibit much larger excursions, in excess of 20%.

**Keywords.** techniques: spectroscopic, surveys, stars: atmospheres, stars: fundamental parameters

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