Possible Channels for Lyman Continuum Escape in the Halo of SBS 0335-52E revealed with VLT/MUSE

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SBS 0335-052: A unique laboratory for physical processes at high-z

SBS 0335-052, at a redshift of $z = 0.0135$, consists of a pair of extremely metal-deficient star-forming dwarf galaxies separated by 22 kpc (projected). The system has long been recognised as a special laboratory for studies of the relevant physical processes in the early universe (Izotov et al. 1990, Papaderos et al. 1998).

Ionised Filaments in the Halo of SBS 0335-052E

We report on the discovery of ionised gas filaments in the circum-galactic halo of SBS 0335-052E in a 1.5 h integration with MUSE.

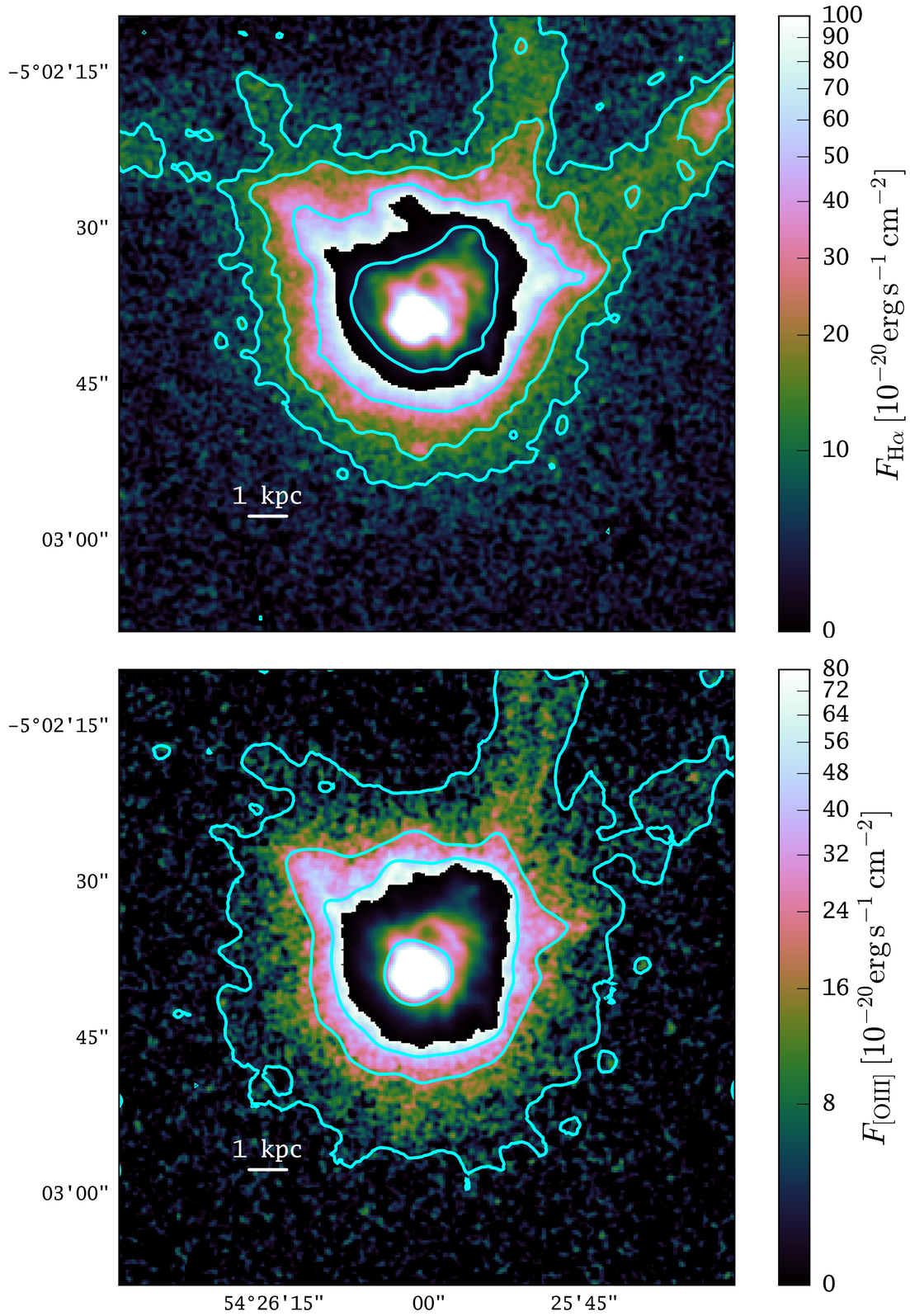

Figure 1: Hα (*top*) and [O III] λ5007 (*bottom*) narrow band images of SBS 0335-052E created from the MUSE datacube. East is left and North is up. Contours are drawn at $[2.5, 5, 12.5, 1250] \times 10^{-18}\,\mathrm{erg\,s^{-1}cm^{-2}arcsec^{-2}}$ for Hα and $[0.5, 5, 12.5, 1000] \times 10^{-18}\,\mathrm{erg\,s^{-1}cm^{-2}arcsec^{-2}}$ for [O III]. To highlight the low-SB features the images have been smoothed with a $\sigma = 1$ px (0.2″) Gaussian.

Filaments in velocity space

By fitting a 1D Gaussian to the Hα line in each spaxel we obtained the velocity field shown in Fig. 2. Our newly detected filaments connect seamlessly in velocity space to the central velocity field.

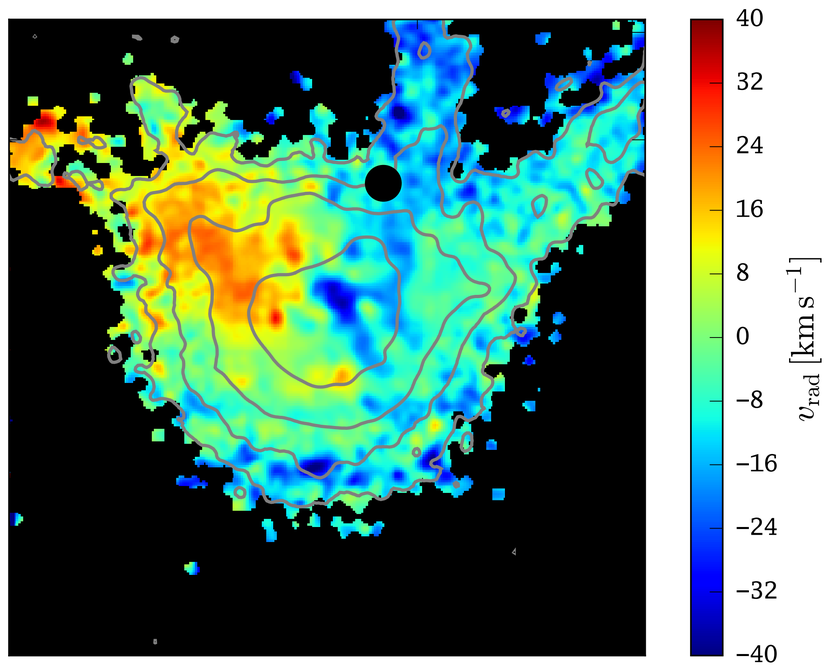

Figure 2: Hα line of sight velocity field with Hα SB contours from Fig. 1. We spatially smoothed the datacube with a tophat filter ($r = 1''$) to enhance the signal to noise for the fit.

The puzzling extended He II λ4686 emission in SBS 0335-052E

SBS 0335-052E also exhibits significantly extended He II λ4686 emission (Fig. 3). Recently, Kehrig et al. (2018) quantified the He II-ionising energy budget of the galaxy using the MUSE observations. This study argues against significant contributions from X-Ray sources and shocks. The identified Wolf-Rayet stars also do not explain the required amount of $E_\gamma > 4$ Ry photons, leading Kehrig et al. (2018) to favour hot massive stars as the main agent of He II-ionisation. However, the used state-of-the-art BPASS models only reproduce the observations at significantly lower-metallicities ($Z/Z_\odot \sim 0.05\%$) than exhibited by the H II-regions ($Z/Z_\odot \sim 3-5\%$, e.g. Papaderos et al. 2006).

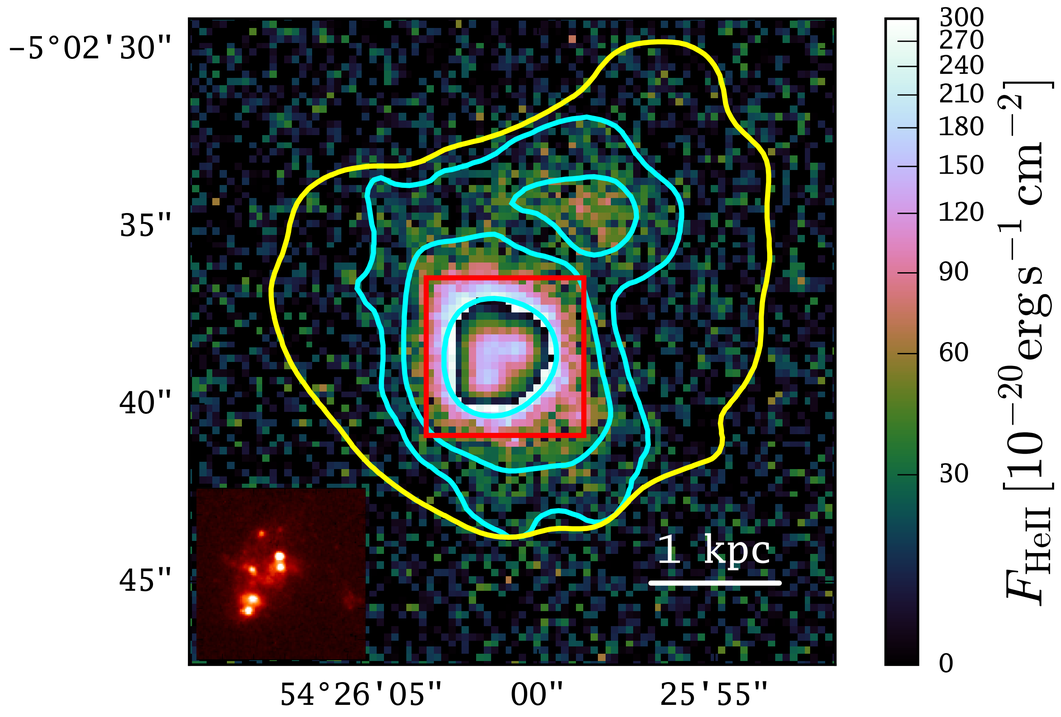

Figure 3: He II narrow band image from MUSE magnified on the central region. The yellow contour is the brightest contour from the Hα image (Fig. 1, top). Contours correspond to $[2.5, 100, 1000] \times 10^{-18}\,\mathrm{erg\,s^{-1}cm^{-2}arcsec^{-2}}$. The inset in the bottom left shows the emission line free HST WFC3/F550M image from the galaxy within the region indicated by the red square.

H II filaments: Channels for Lyman continuum escape?

21cm observations reveal that the SBS 0335 system is surrounded by a large HI complex (Pustilnik et al. 2001). In Herenz et al. (2017) we conjectured that the reduced neutral fraction within the ionised filaments could advocate an escape of LyC photons from the starburst into the intergalactic medium. Indeed, newly obtained VLA-B configuration data hints at decreased neutral columns co-spatially aligned with two filaments (Fig. 4). However, in order to trace the full extend of the filaments additional MUSE observations are required. In the future we aim at a combined HI-HII study of unprecedented depth and quality in the circum-galactic environment of this intriguing galaxy.

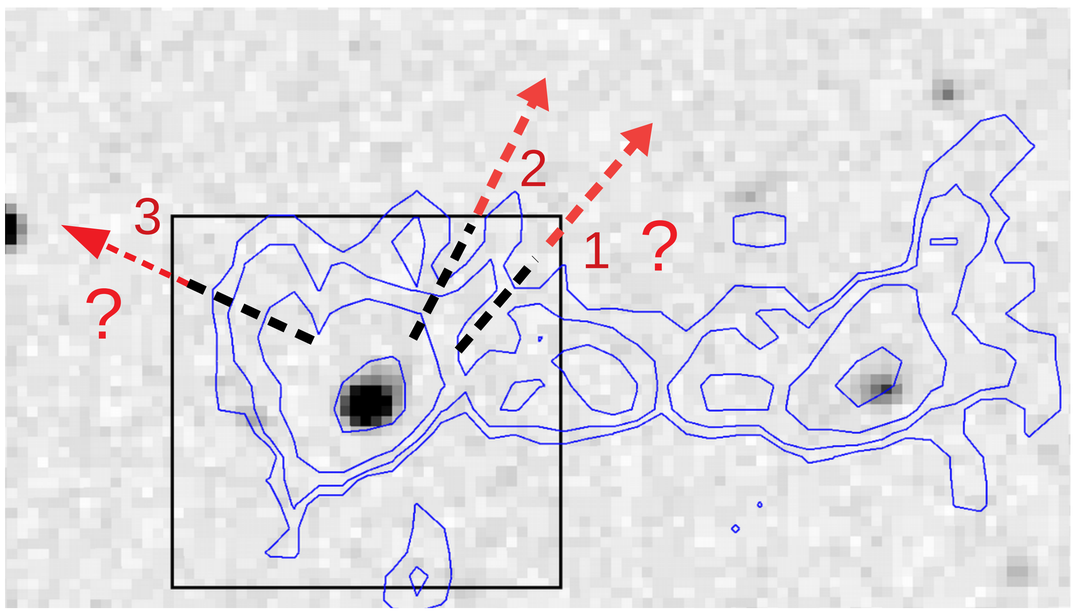

Figure 4: Newly obtained VLA HI 21cm observations, first reduction of 3h from the total 30h dataset. Lowest contour corresponds to $N_{\mathrm{H}} = 8 \times 10^{19}\mathrm{cm^{-2}}$. Black square corresponds to our original MUSE pointing, and the arrows indicate the position and direction of the H II filaments. Further MUSE observations would be desirable to trace their full extend.

References

Herenz, E. C. et al. 2017, A&A, 606, L11 • Izotov, Y. I. et al. 1990, Nature, 343, 238 • Kehrig, C. et al. 2018, MNRAS, 480, 1081 • Papaderos, P. et al., A&A, 338, 43 • Pustilnik, S. A. et al. 2001, AJ, 121, 1413