Lyman continuum photon escape in local early-type galaxies

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We use integral field spectroscopy (IFS) data from the CALIFA survey (Sánchez et al. 2012) for a spatially resolved study of faint nebular emission in early-type galaxies (ETGs) in the local (<100 Mpc) Universe.

Methodology

i) CALIFA IFS data for 105 ETGs were processed with the pipeline Porto3D (Papaderos et al. 2013, Gomes et al. 2016), which, among other tasks, permits spaxel-by-spaxel spectral fitting with the population synthesis code STARLIGHT (Cid Fernandes et al. 2005) and subsequent determination of emission line fluxes and their uncertainties from the pure emission-line spectrum (i.e., the observed spectrum after subtraction of the best-fitting synthetic stellar model).

ii) The Lyman continuum (LyC) photon rate from the post-AGB stellar component was computed and used for the determination of Balmer-line luminosities, assuming case B recombination for an electron temperature and density of 10^4 K and 100 cm^{-3} , respectively.

iii) The distance-independent τ ratio (ratio of the Hα luminosity that is theoretically expected from photoionization by post-AGB sources and the observed Hα luminosity; Papaderos et al. 2013) was computed.

$\tau > 1$ corresponds to leakage of a fraction $f_{esc} = 1 - 1/\tau$ of the intrinsically produced LyC photons by post-AGB sources, whereas $\tau < 1$ implies an extra gas excitation mechanism (e.g., low-level star formation, shocks, AGN).

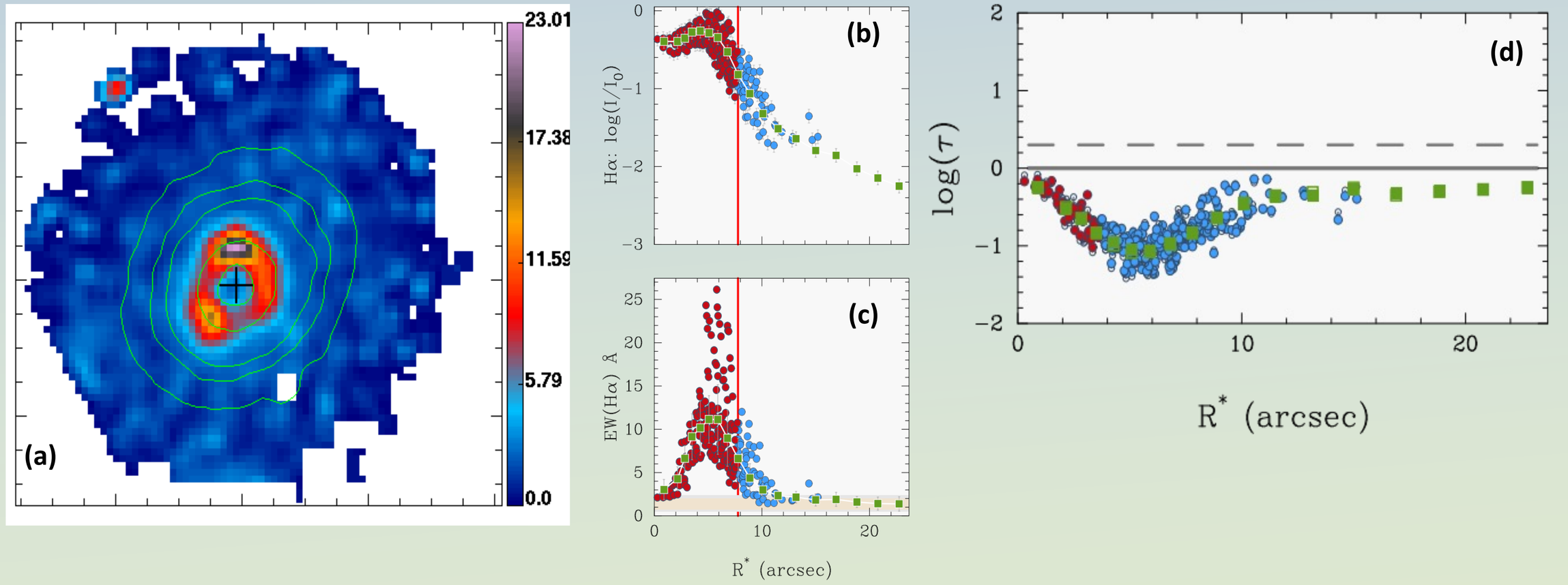
Results

Approximately 40% of our sample is characterized by $\tau \leq 1$ over the entire galaxy extent (for example, NGC 3182), which implies zero LyC photon escape and/or a diffuse ionizing field by low-level star formation.

However, the τ ratio in the majority (60%) of ETGs was determined to be >6 (for example, in NGC 1060), implying that most of the ionizing radiation produced by post-AGB sources escapes into the circumgalactic medium without being reprocessed into nebular emission, as a result of the low gas density in these systems.

A consequence of this is that the line-weakness of ETGs is no compelling evidence for them containing a merely “weak” (sub-Eddington accreting) low-luminosity active galactic nucleus (AGN). In fact, LyC photon escape, which has heretofore not been considered, may constitute a key element in understanding why many ETGs with prominent signatures of AGN activity in radio continuum and/or X-ray wavelengths show only faint emission lines and weak signatures of AGN activity in their optical spectra.

NGC 3182



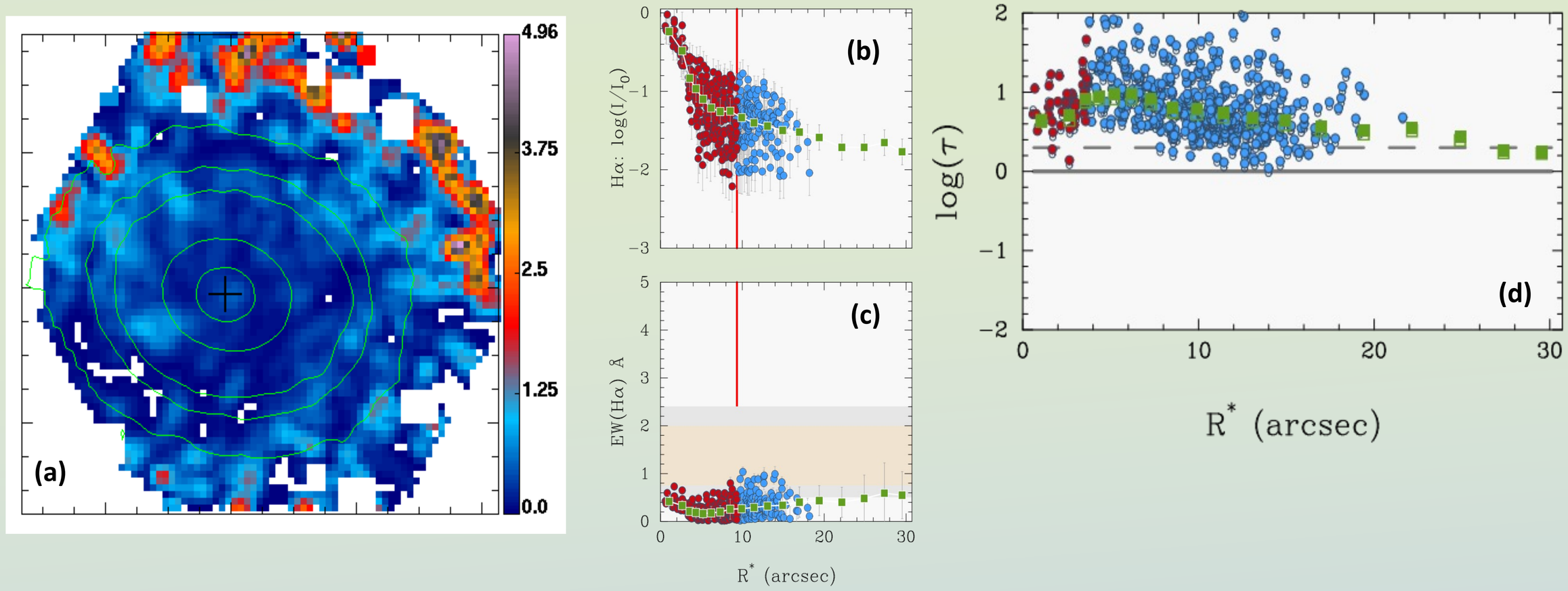
a) Hα equivalent width (EW(Hα)) map,

b) radial Hα intensity profile (normalized to the maximum Hα intensity). The effective radius of the galaxy is indicated by the vertical line.

c) radial EW(Hα) profile. The gray-shaded area depicts the range of EW(Hα) values that can be accounted for by photoionization by post-AGB sources.

d) radial profile of τ.
τ>1 corresponds to LyC photon escape.

NGC 1060



References

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