Planetary Nebulae as a probe of the evolution of the central kiloparsec of Andromeda

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Summary

We present new spectral observations of Andromeda's bulge region obtained with SITELLE instrument. With this data we were able to :

- Detect **550+ Planetary Nebulae** and classify them on diagnosis diagrams
- Identify a **bimodal distribution** of the PNe population, that could be correlated with M31 physical substructure

Introduction

Andromeda's bulge is a close-by example of a typical green-valley galaxy, representing the transition between star-forming and quenched galaxies, and is a perfect testbed to investigate the low ionization emission line regions (LIERs) properties. PNe are very good tracers of the overall population of a galaxy, and their progenitors, post-AGB stars, are thought to be ionizing sources in LIERs galaxies. Besides, there is an observational consensus on the universality of the bright-end cutoff of the Planetary Nebulae Luminosity Function (PNLF) in every type of galaxies (including M31's bulge), in strong disagreement with synthetic models, that predicts that bright PNe are indicator of a star formation event younger than ~ 1 Gyr old.
Analyzing M31's bulge PNe population can help answer the questions : Does this old bulge holds a bright PNe population ? Is star formation still ongoing ?

Data

We obtained with SITELLE instrument installed at CFHT unprecedented spatial and spectral resolution on Andromeda's central kiloparsec, to analyse **[OIII]$\lambda\lambda$5007,4959**, **Hβ**, **Hα**, **[NII]$\lambda\lambda$6548,6584** and **[SII]$\lambda\lambda$6716,6731** emission-line objects.

Filter	SN2	SN3
Field of view	11'×11'	11'×11'
Pixel scale	0.321"	0.321"
Spectral range [nm]	483 - 513	647 - 686
Channel width [km.s^{-1}]	83.0	42.0

Table 1: Observation parameters.

Diagnosis Diagrams

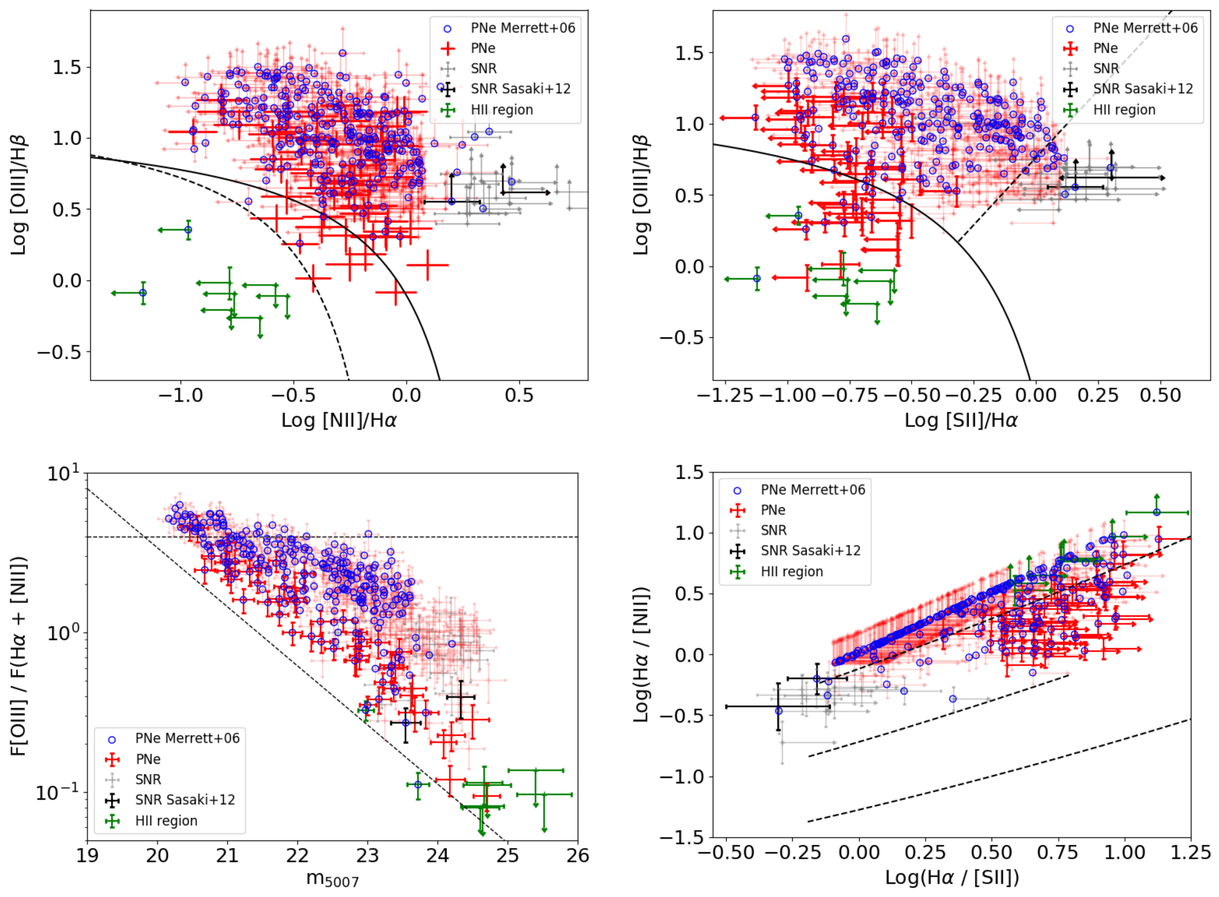

Figure 1: Diagnostics diagrams of the detected sources. We show in green : HII-regions candidates, in grey : Supernovae Remnants candidates, in **black : confirmed Supernovae Remnants by Sasaki et al (2012)**, in red : PNe candidates and in blue : match in Merrett et al (2006) catalog. We used the top left BPT diagram to classify our sources between HII-regions (8), PNe (565) and Supernovae Remnants (17) candidates. We use upper or lower limits when the measured flux was less significant than 3σ. Top row : BPT diagrams. Classification lines are from Kewley et al. (2001) and Kauffmann et al. (2003). Bottom left : Flux ratio F([OIII])/F(Hα + [N II]) with respect to the relative m_{5007} magnitude. Classification lines are from Herrmann et al (2008). Bottom right : SMB diagram, with classification lines from Frew & Parker (2010).

Planetary Nebulae Luminosity Function

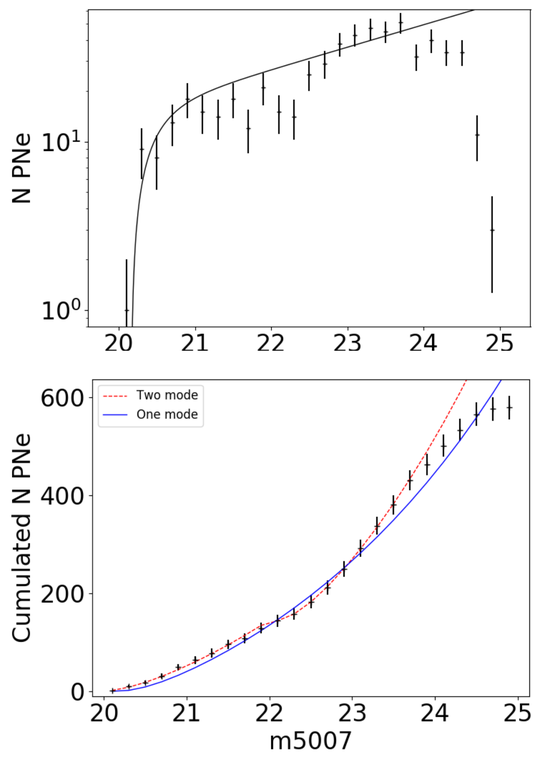

Figure 2: Left : Classic PNLF, with a fit using Jacoby et al. (1989) shape. The fitted bright-end cutoff is $\mathbf{m^*_{5007} = 20.14 \pm 0.248}$, in very good agreement with the "universal" value. We observe a dip 2 mag inside the PNLF. Right : Cumulative PNLF with fit of a simple and double component (Rodríguez-González et al. (2015)). The two mode yields a magnitude cut $\mathbf{m_{cut} = 21.97 \pm 0.16}$.

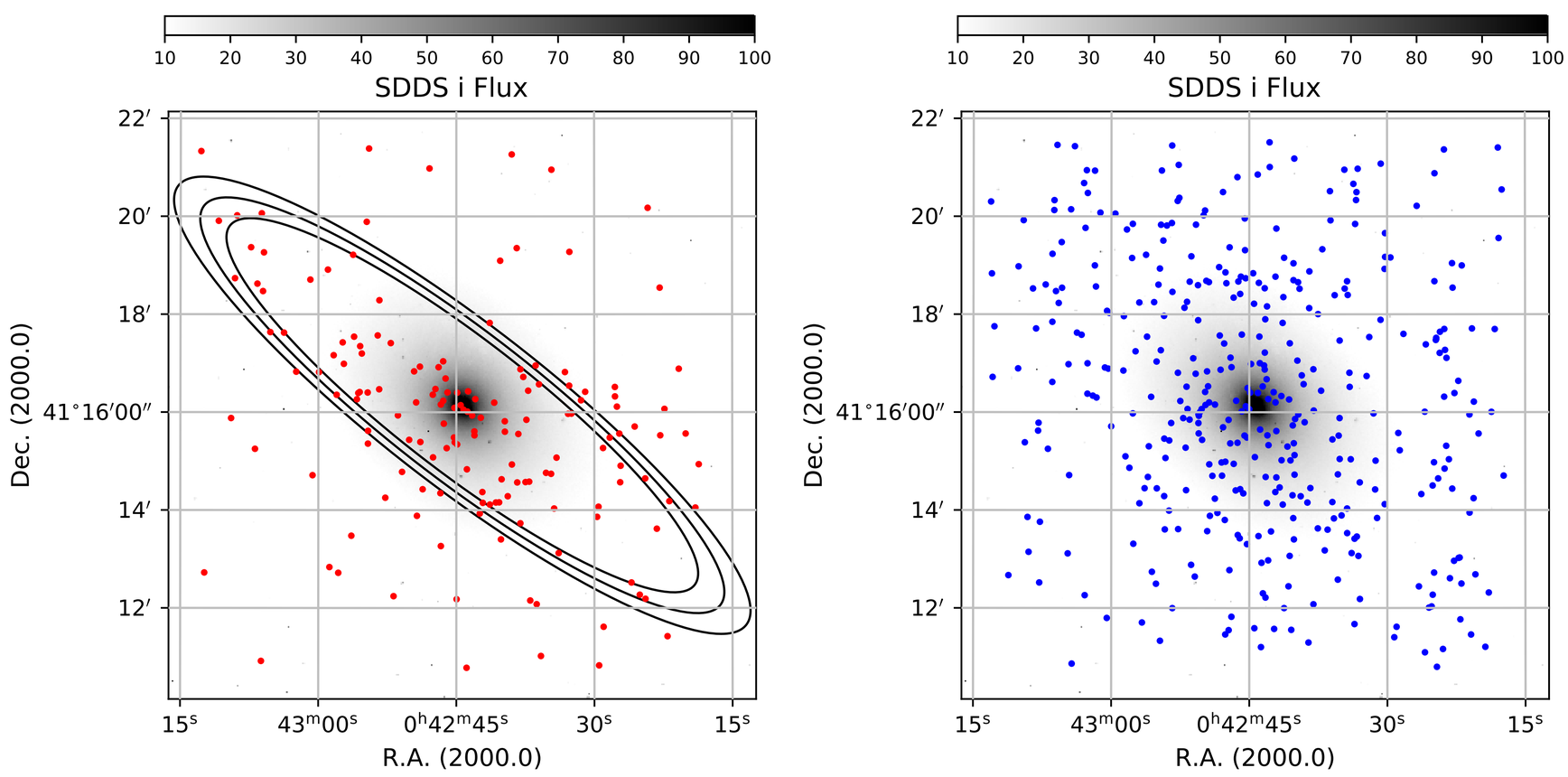

Figure 3: Left (resp. Right) : Spatial distribution of the bright (resp. faint) PNe population, i.e. with $m_{5007} < 22.0$ (resp. $m_{5007} > 22.0$) over a SDSS i-band image. Ellipses have Andromeda's disc inclination and position angle. The brighter population seems to correlate with the disc, while the fainter is more randomly distributed, as expected for the bulge.

Conclusion

We identified **565 PNe candidates confirmed with emission-line diagnosis diagrams**. The PNLF reveals a bimodal distribution, that could be related to **two spatially distinct populations** : the brighter (younger) belonging to the disc, and the fainter (older) belonging to the bulge. This would solve the issue of the universality of the bright-end cutoff of the PNLF.

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References

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