

Title: Absorption lines due to neutral gas infalling onto M31's bulge

Keywords: galactic feedback, galactic dynamics, kinematics, simulator of observations

Scientific description:

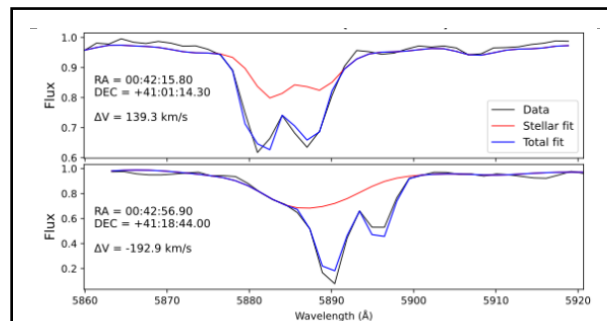
The Andromeda galaxy is a nearby spiral located at 780 kpc, which has the particularity to have quenched its star formation activity in the central kpc. Observations of various objects (about 1000 in the CfA archives, <https://oirsa.cfa.harvard.edu/>) in this region revealed the presence of neutral gas (sodium doublet line) along the line of sight. The kinematics of this gas points towards infalling gas, as expected by the main feedback mechanisms. However, this result is completely new and quite surprising. We need to secure the detection.

While originally known from early stellar studies (Lèbre & Gillet 1991, *A&A*, 251, L549; Terrell et al. 2005, *MNRAS*, 360, 583; Kohl et al. 2016, *A&A*, 591, 20), this method has also been developed with extragalactic motivations for the detection of central outflowing gas by Rupke et al (2005a, *ApJS*, 160, 87; 2005b, *ApJS*, 160, 115), on bright sources, and stacked data (Roberts-Borsani et al. 2020, *MNRAS*, 493, 3081). Sarzi et al. (2016, *MNRAS*, 456, 25) discussed that this feedback could be due to star formation rather than from the central black hole.

As displayed in the figure, the spectra is dominated by the stellar continuum (in red) that needs to be subtracted first. This first fit (already done) gives the velocity of the stellar components. The NaID gas seen in absorption is shifted at a velocity different from the stellar one.

The goal of this internship is to characterise this detection and to demonstrate the statistical significance of the detection. First, a simulation tool will be developed to reproduce observations with the modelling parameters and to include the observational characteristics (level of noise typical of observations, resolution, sampling, etc.). Second, this simulation tool will be used to characterise the signal detected in the data.

This work will be done in collaboration with Marc Sarzi (Armagh Observatory, UK).



Examples of detection of the sodium doublet in the direction of two stars, with spectra from Li et al. (2018). The stellar adjustment was made with Nburst, and the neutral gas has an average velocity that is very clearly offset from that of the stars.

Techniques/methods in use: python, data analysis, statistics, visualisation

Applicant skills: physics background, python and computing skills, experience of numerical projects or data analysis welcome.

Industrial partnership: N

Internship supervisor(s) (name, email, phone, ...): Anne-Laure Melchior,
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Internship location: 77 avenue Denfert-Rochereau 75014 Paris

Possibility for a Doctoral thesis: Eventually after M2 (through Ecole Doctorale)