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THE DETECTION OF SUPERGALACTIC WINDS: THE EDGE-ON STARBURST GALAXY NGC 4631

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We are studying a sample of spiral galaxies which host nuclear starbursts. Our aim is first to detect supergalactic winds (SGWs) and second to establish the conditions needed for the onset of the supergalactic wind phase. In this contribution we present preliminary work on the galaxy NGC 4631.

We analyze Fabry–Perot observations (TAURUS) taken at the 4.2 m William Herschel Telescope Roque de los Muchachos Observatory (ORM). Data have been complemented with long slit spectroscopy (ISIS) taken from the La Palma (ORM) data archive. Recently X-ray observations from *Chandra* have evidenced the escaping of hot gas from the disk into the halo. We identify possible SGW features on both sides of the disk. Emission lines are split revealing outflows and blow-out into the galactic halo. More detailed analysis has been undertaken in order to decide wether or not the galaxy has an SGW. Typical sizes of split lines areas range from 55 pc (a bubble feature) to 142.5 pc, the largest extent. Velocities of split lines range from 40 km s^{-1} to 85 km s^{-1}.

1. INTRODUCTION

X-rays observations provide the only direct probe of the hot, metal-enriched gas that fills most of the volume of superbubbles and contains most of the energy from a starburst. Confining structures may show optical line emission, most notably in Hα, which is therefore an indirect probe of such activity.

We are looking for galaxy candidates for supergalactic winds, among which there are those in which extended X-ray emission has been detected, M82 being a clear case. Important bubble-like X-ray emission was first detected and the collimating cones were found in an Hα image taken with Subaru. Is NGC 4631 another example?

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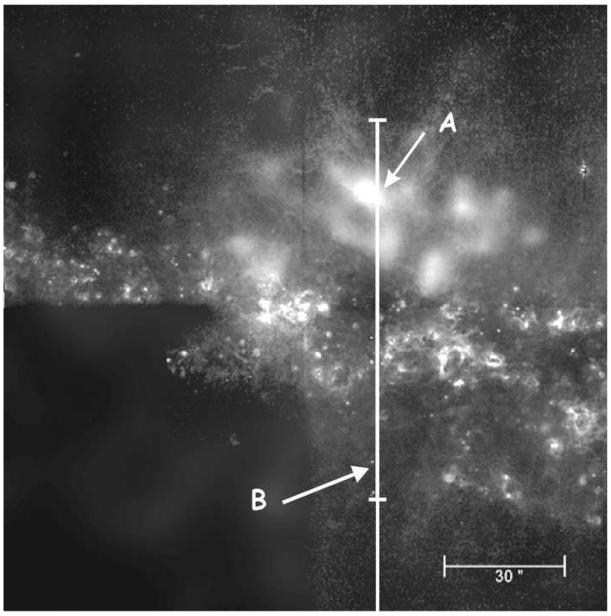

Fig. 1. *Chandra* has detected a halo of hot gas around NGC 4631. We can see in this image the X-ray and Hα emission composite. We have overlaid the dimension and position of the slit. (Color images in http://-chandra.harvard.edu/photo/cycle1/1138/index.html.) NASA/UMass/D.Wang et al.; NASA/HST/D.Wang et al.; NASA/CHANDRA/D.Wang et al.

2. TAURUS RESULTS

- We detect SGW features in the ionized gas, in the SE direction.
- Hα features detected within the halo (SE) are not at the systemic velocity but blueshifted by 1.1 Å and 1.16 Å, equivalent to 50 km s^{-1} and 53 km s^{-1} in the Hα emission line.
- However, we fail to identify optical features to the north, contrary to what would be expected from the high emissivity detected in X-rays.

3. LONG SLIT RESULTS

We are looking for features in Hα that coincide with the emission observed in X-rays. With TAU

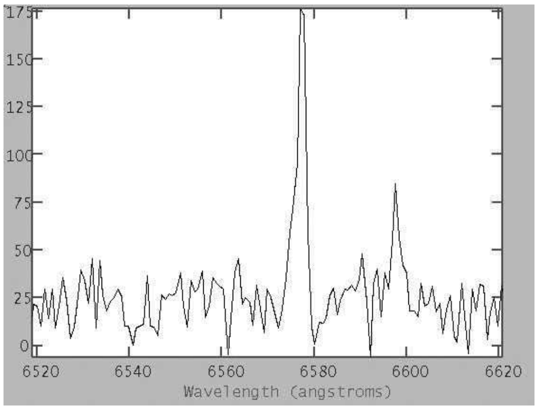

Fig. 2. A spectrum: nO the north side of the galaxy we found line splitting and the size of the peculiar line profiles is about 6″ (142.5 pc).

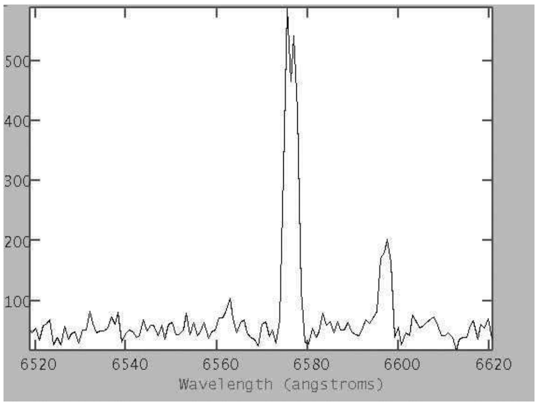

Fig. 3. B spectrum: In the middle of the galaxy we also found line splitting over a distance of 55 pc.

RUS we found evidence SE of the galaxy, although no signatures were identified to the north (where the X-ray emission is more intense). In the long slit spectra we found line splitting in both directions.

- The emission line of the galaxy in wavelength range [6200,6900] shows a strong emission line in Hα, nitrogen [N II] and sulfur [S II] doublets are also clear.

- Well inside the disk (B spectrum) we can see a line splitting in the Hα line over a distance of 55 pc. We identify this feature with a bubble.

- On the north side of the galaxy (A spectrum) emission lines are also double. In the outer zones we do not have enough signal to disentangle whether the Hα emission is contained within the halo or shows an open, cone-like estructure.

- To the south the behavior is similar and shows a similar extent in Hα.

- The size of the peculiar line profiles is about 6″ (142.5 pc) and the line separation accounts for velocities in the range 40 km s^{-1} to 85 km s^{-1}.

We conclude that NGC 4631 might be another case with SGWs. However, more careful study has to be carried out in order to decide whether or not the hot gas can escape the galaxy potential and blowout into the intergalactic medium.

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