

GMOS IFU observations of a wandering black hole in NGC 5252

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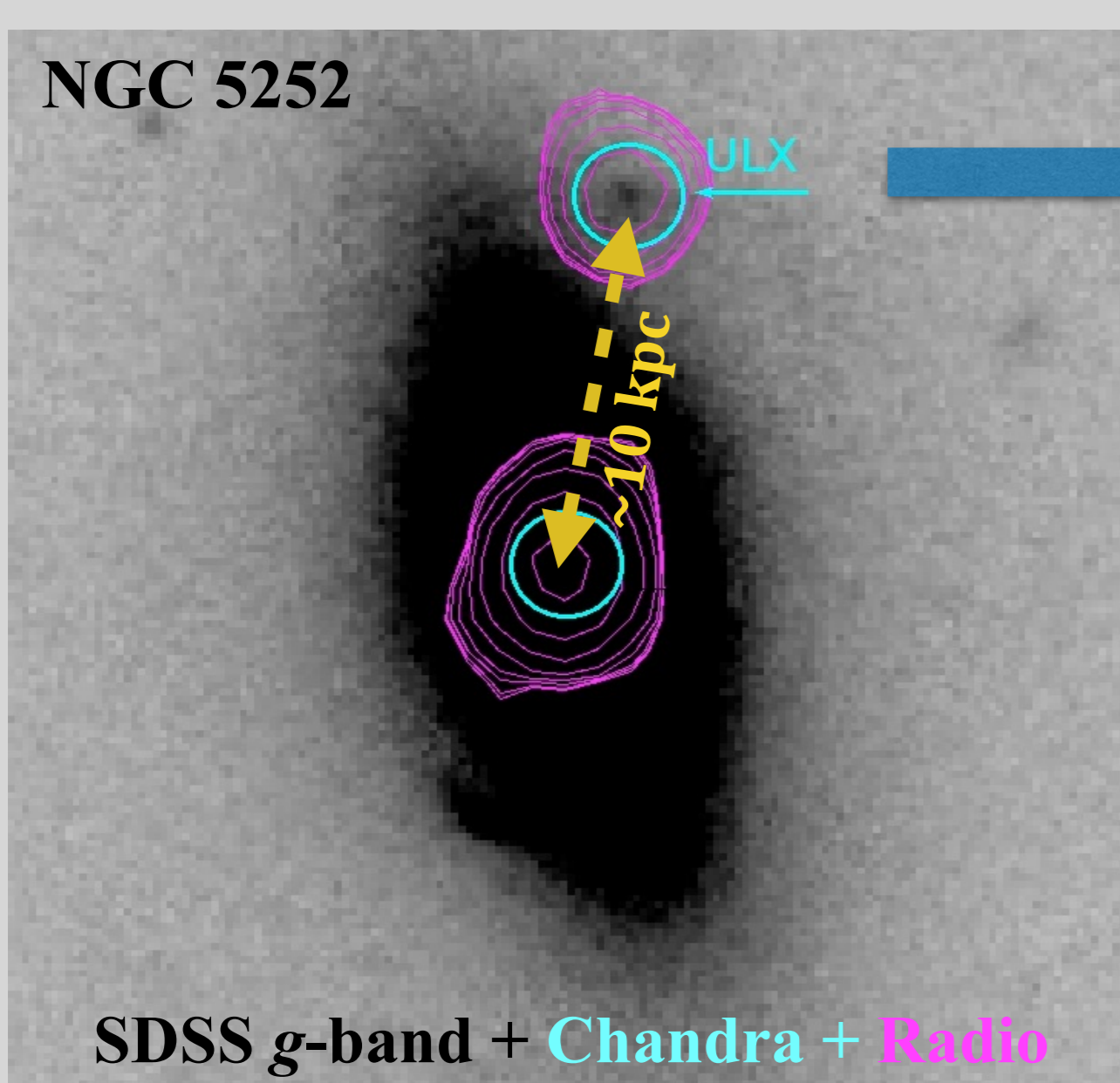
Abstract

We recently found an ultraluminous X-ray source in NGC 5252, which is a possible candidate of an off-nuclear non-stellar black hole. We present a follow-up study of the optical IFU spectrum obtained with Gemini-N/GMOS. Using the IFU data, we again confirm that the redshift of the ionized gas at the position of the ULX coincides with that of NGC 5252. The spectroscopic information of the ionized gas around the ULX reveals that the gas is rotating with the ULX. This findings possibly indicates that the ULX is NOT a background source, but the actual ionizing source of the surrounding gas. It supports the idea that the ULX is an off-nucleus AGN associated with NGC 5252. We find the maximum velocity of the rotating gas is relatively small, indicating that the progenitor of the ULX can be a nucleus of a dwarf galaxy.

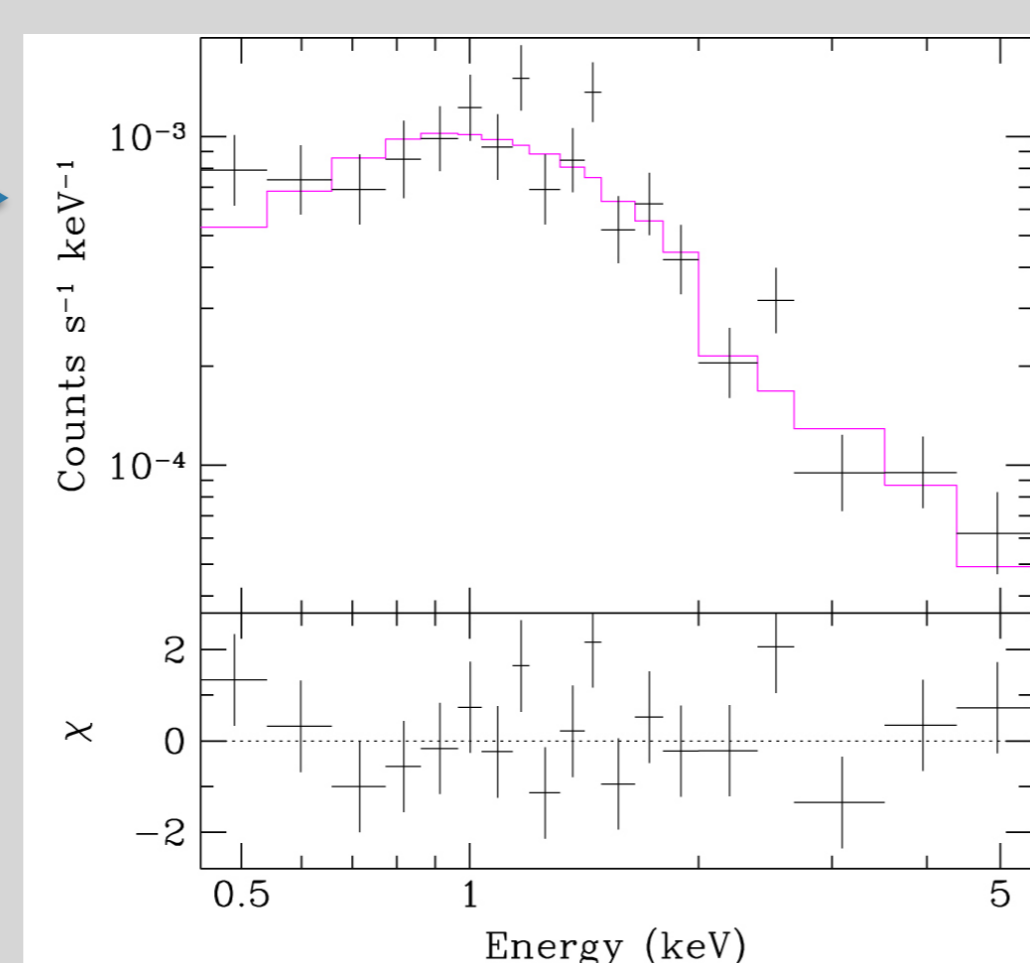
Introduction

- Intermediate Mass Black Holes (IMBH)
 - $10^2 \sim 10^5 M_{BH}$
 - Possible building block of supermassive black holes
 - extremely rare population!
- Effort to find IMBHs?
 - Low-mass active galaxies (e.g., Greene & Ho 2004, Reines et al. 2013)
 - Massive star clusters (G1, w Cen, M54)
 - **Ultraluminous X-ray sources (ULXs)**

ULX in NGC 5252 : Candidate of IMBHs?



Kim et al., 2015

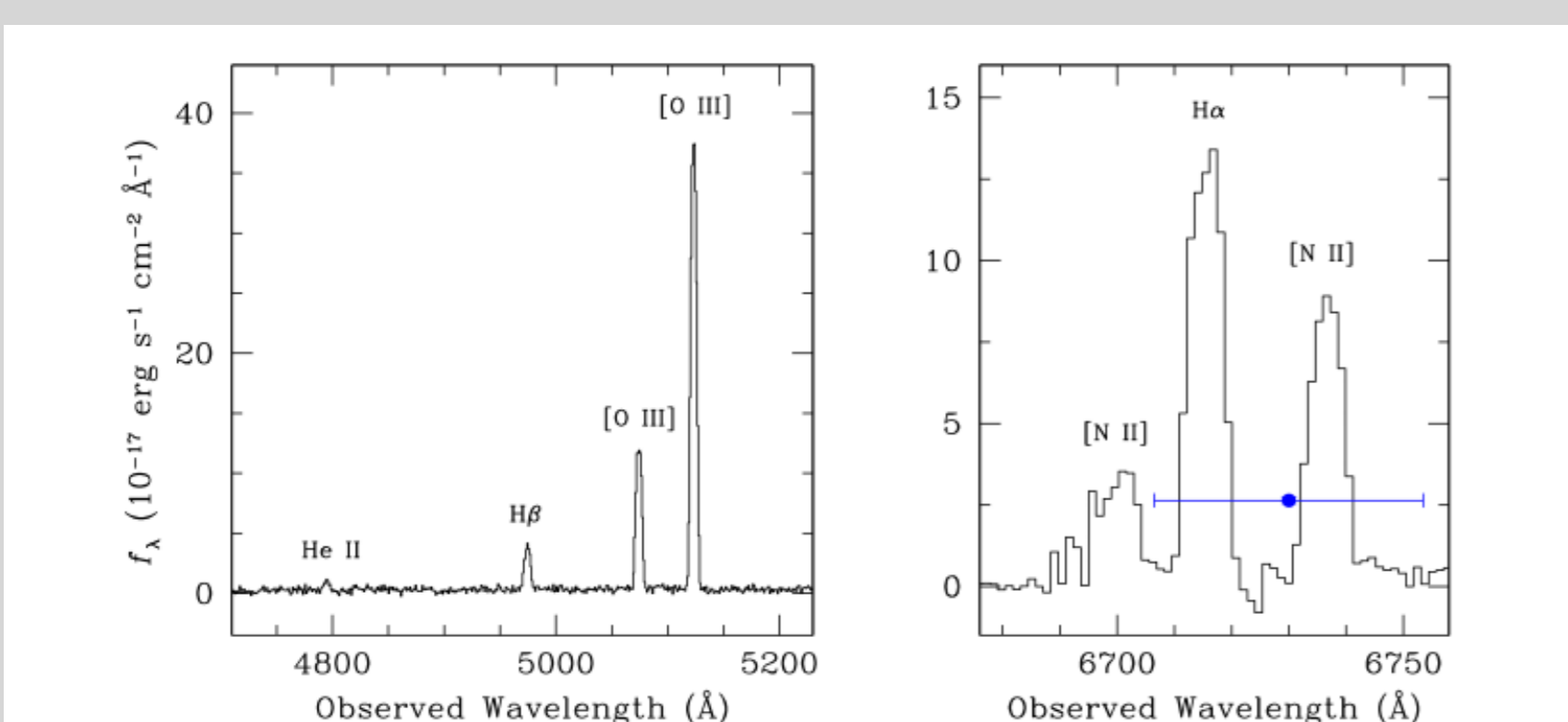


Chandra X-ray spectrum of the ULX

- $L_{X\text{-ray}} \sim 10^{40} \text{ erg s}^{-1}$
- $N_H \ll 10^{22} \text{ cm}^{-2}$
- $L_{5\text{GHz}} \sim 10^{21} \text{ W Hz}^{-1}$

1. Foreground star? : very unlikely
2. Background AGN? : unlikely
(no emission line from the background AGN).
3. Stellar mass BH? : unlikely; Radio flux is too high, very weak variation in radio and X-ray.

4. Off-nucleus IMBH? (or SMBH?) : very likely

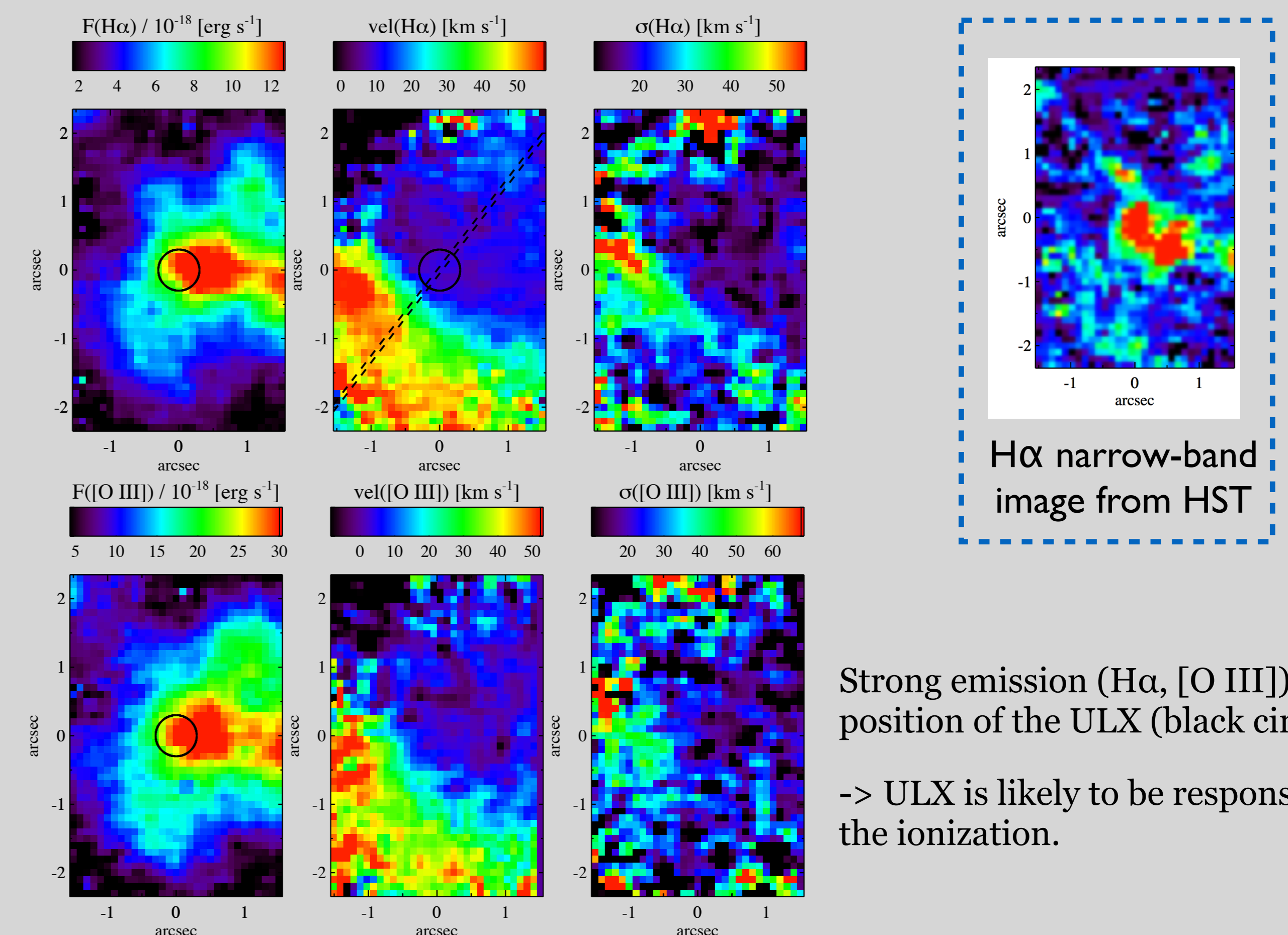


Magellan/IMACS spectrum of the ULX

- Appears to be associated with the host galaxy (NGC 5252)

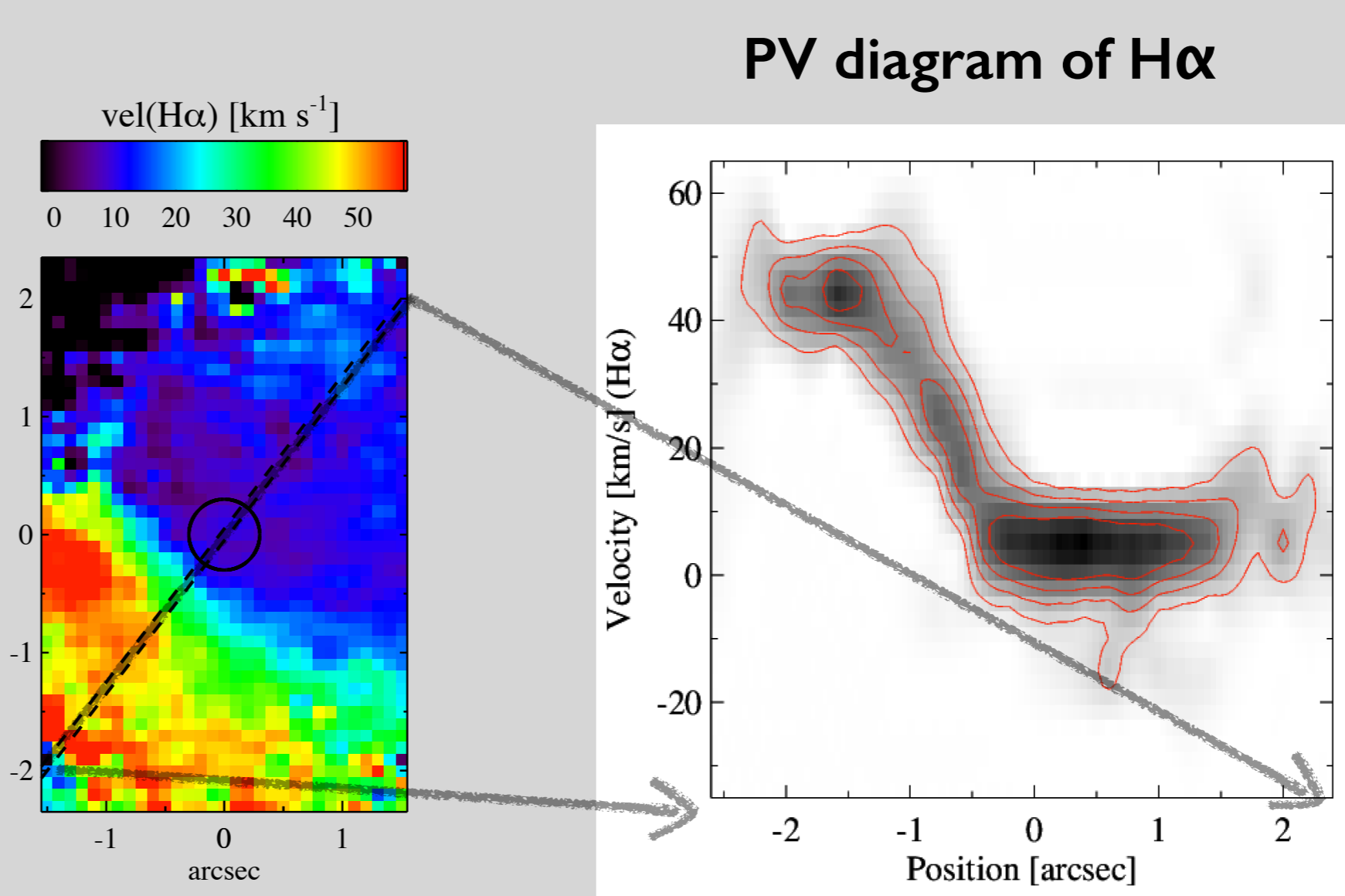
- Seyfert-like spectrum

Gemini/GMOS IFU Observation



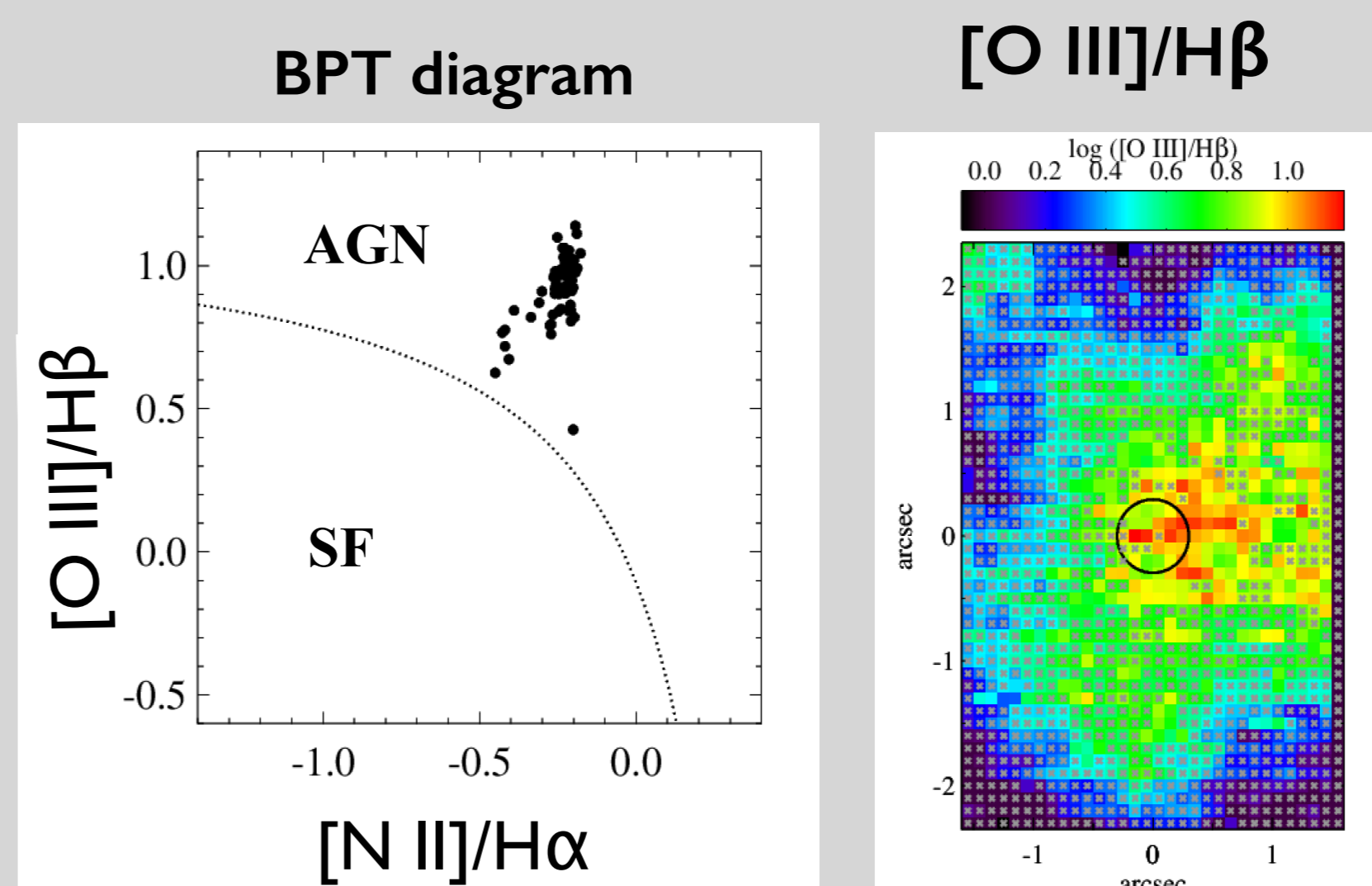
Strong emission ($H\alpha$, $[O III]$) at the position of the ULX (black circle)
 -> ULX is likely to be responsible for the ionization.

Rotation vs. Shock?



- Sign of rotation
 $M_{\text{dyn}} \sim 10^{7.5} M_{\odot}$
- Offset between the ULX and the center of the rotation curve.
- Shock?
- Possible, but not a major source of the ionization for the entire region.

Source of Ionizing radiation?



- AGN-like X-ray/UV continuum appears to be responsible for the ionization (BPT diagram).
- Higher $[O III]/H\beta$ ratios underneath the ULX indicates the ionizing continuum might come from the ULX.

Summary & Discussion

- GMOS/IFU data show sign of rotation.
- Ionizing radiation might come from the ULX.
- Shock is unlikely to be responsible for the ionization of the entire region.
- Origin of the ULX?
 - probably a nucleus of a merging dwarf.
 - the derived dynamical mass ($10^{7.5} M_{\odot}$) indicates that the ULX can be a possible candidate of intermediate mass BH.