Watching Aurora in Passive Galaxies: Temperature measurement and constraint on ionization source

Man Yin Leo Lee and Renbin Yan
Department of Physics, The Chinese University of Hong Kong

What is ionization?
- In the interstellar medium, ionization refers to the process describing an atom losing electrons and becoming positively charged due to external energy input.
- There are different levels of ionizations. Atoms can lose single or multiple electrons depending on the energy input.

Scientific Problem
- Low-ionization Emission Line Regions (LIERs) are regions that contain large amounts of low-level ionized atoms.
- LIERs are found in elliptical galaxies which are old and evolved. Ionization sources of these LIERs remain unknown.
- Active Galactic Nuclei were thought to be the source of ionization but spatially resolved observation proved that LIERs extend outside the nuclear region.
- Different sources inject energy differently, giving the interstellar medium different temperatures, providing astronomers a way to solve the mystery.
- Popular candidates: (1) Light from old stars, (2) Supersonic shocks induced by collisions between gas clouds.

Methodology
- Light we see is added up by light in different wavelengths.
- Different wavelengths of light can be decomposed by a spectrograph.
- Auroral light is from certain wavelengths and is dependent on the temperature of the origin.
- By measuring the amount of light in those wavelengths, the strength of auroral light can be obtained.
- The plot of strength versus wavelength is called a spectrum.

Auroral lines
1. Name: [NII] \( \lambda \lambda 5755 \)
   Color: Green
2. [SII] \( \lambda \lambda 4068,4076 \)
   Color: Purple
3. [OII] \( \lambda \lambda 7320, 7330 \)
   Color: Red
4. [OIII] \( \lambda 4363 \)
   Color: Blue

LIERs observed outside nuclear region

Future directions
- Investigate the possibility of different ionization sources in different parts of the galaxy or different galaxies.
- Improve the model and make deeper observations.