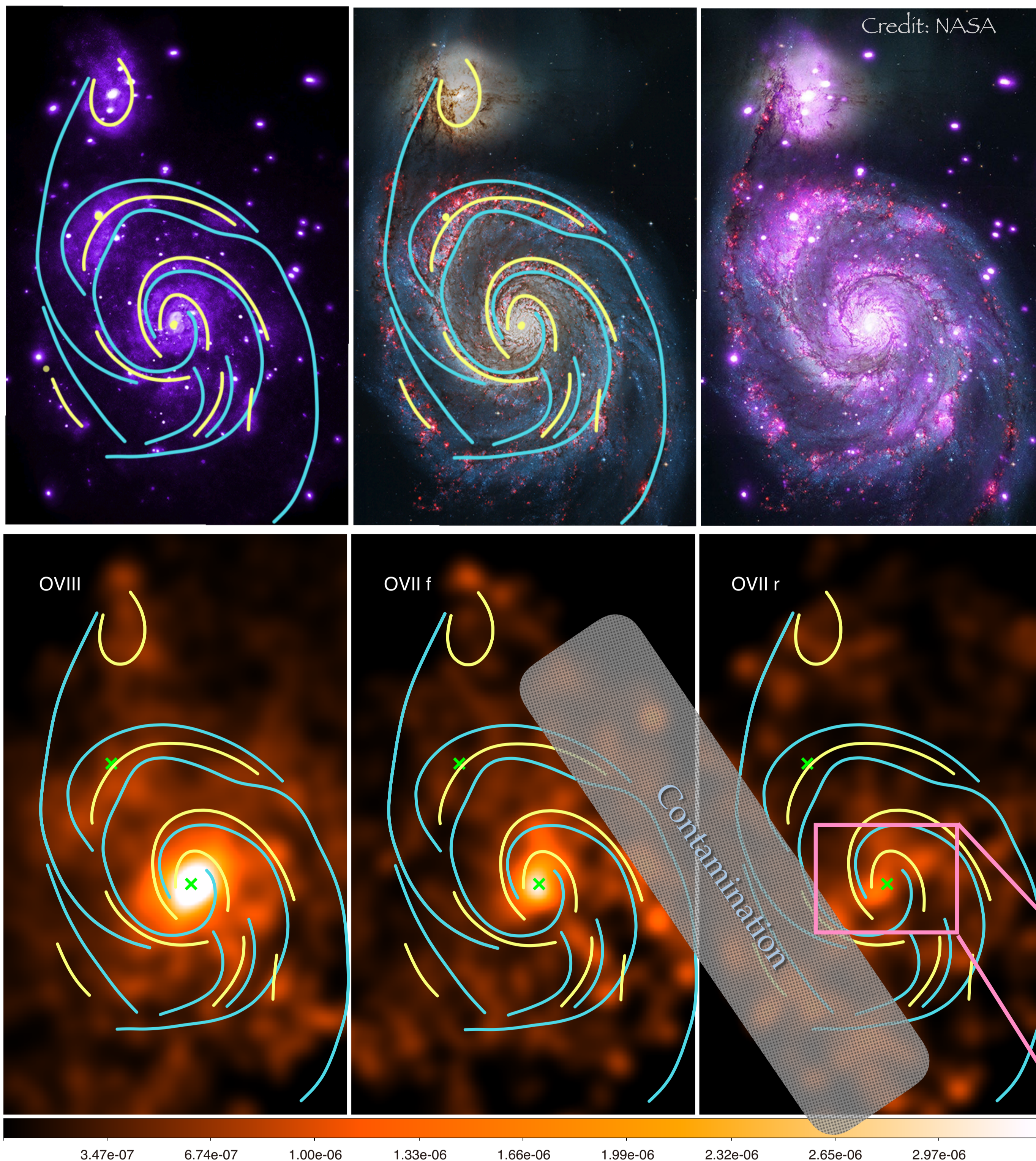
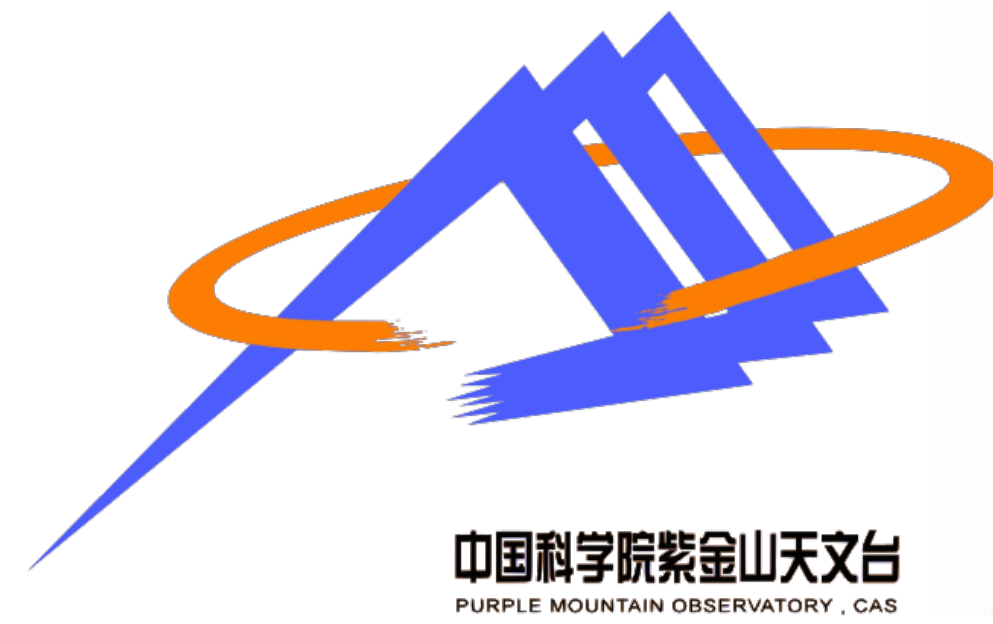
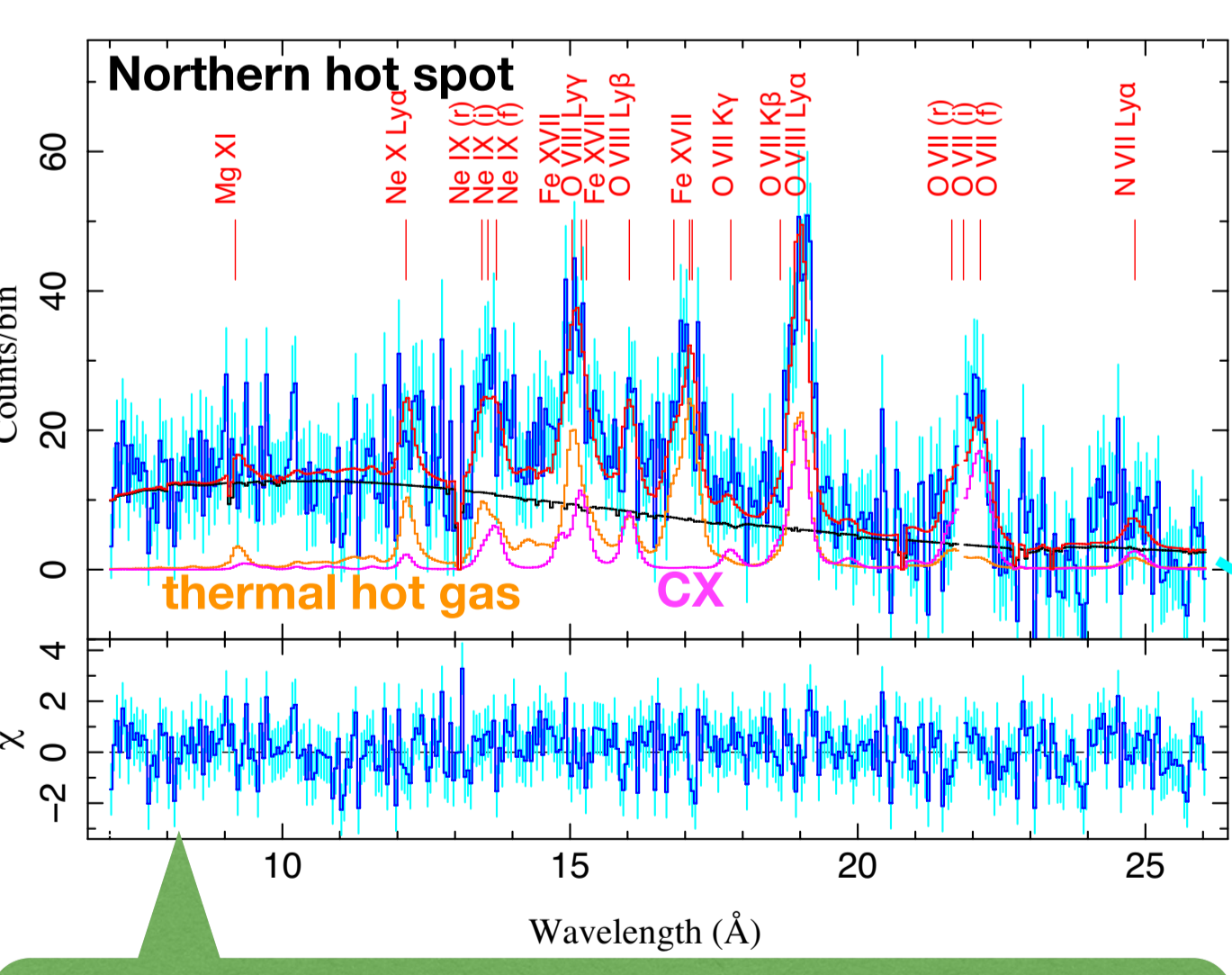
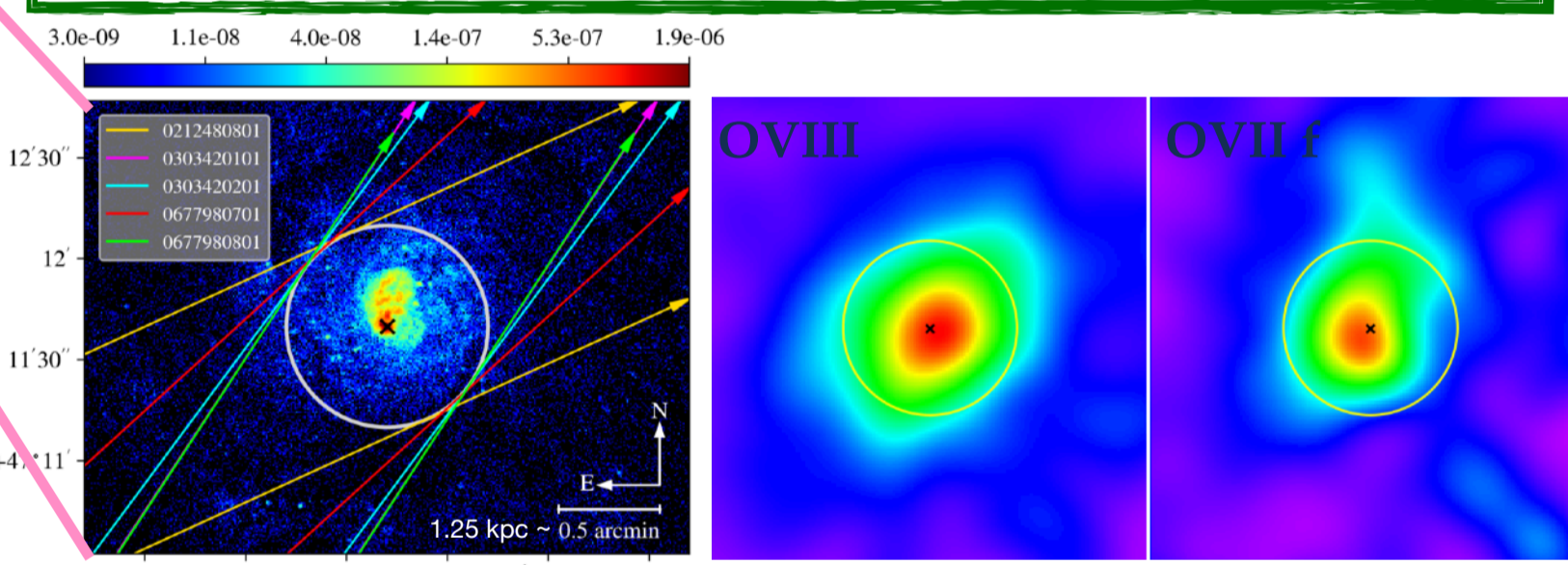


Charge Exchange in the Central Region and on the Arms of M51

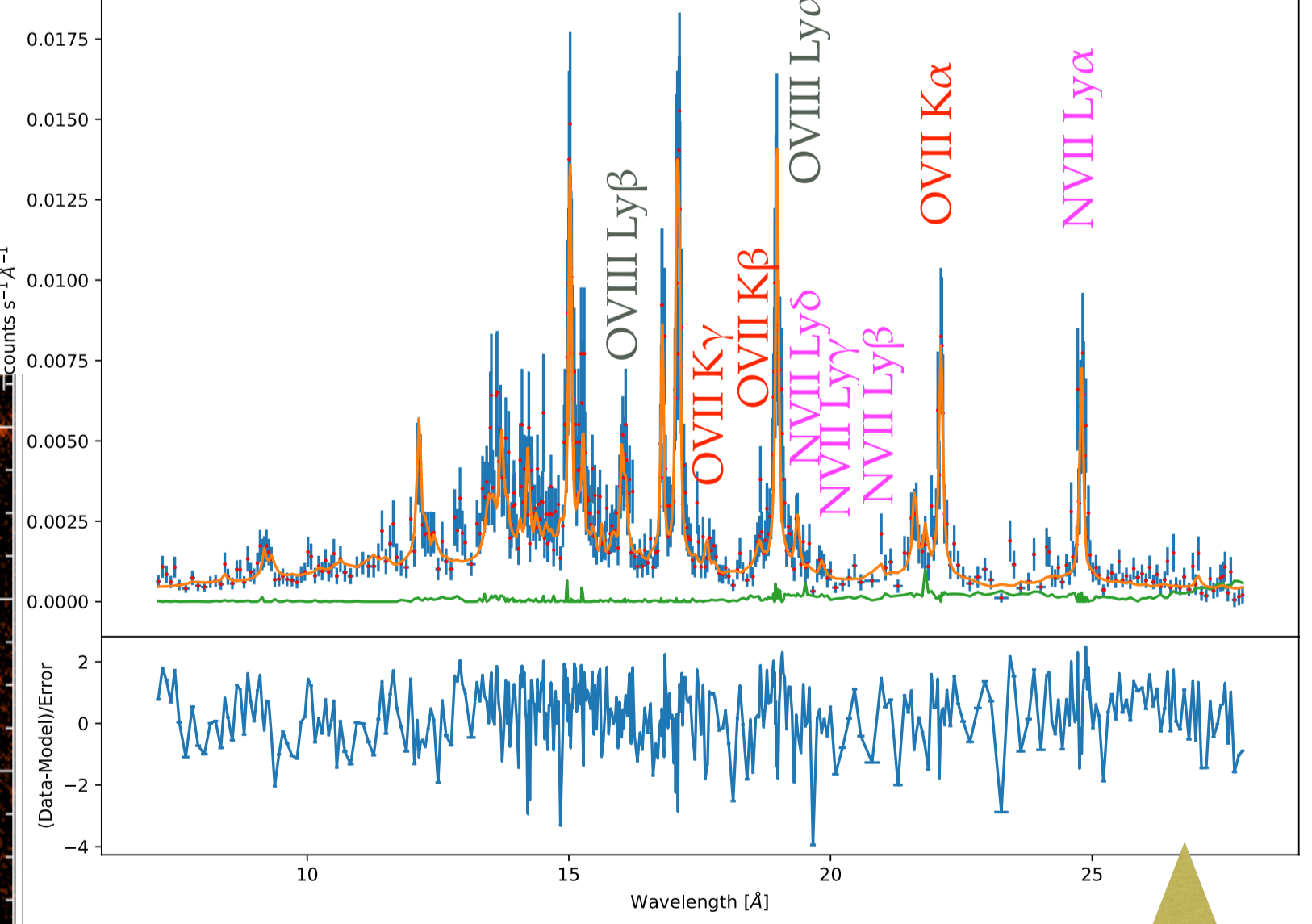
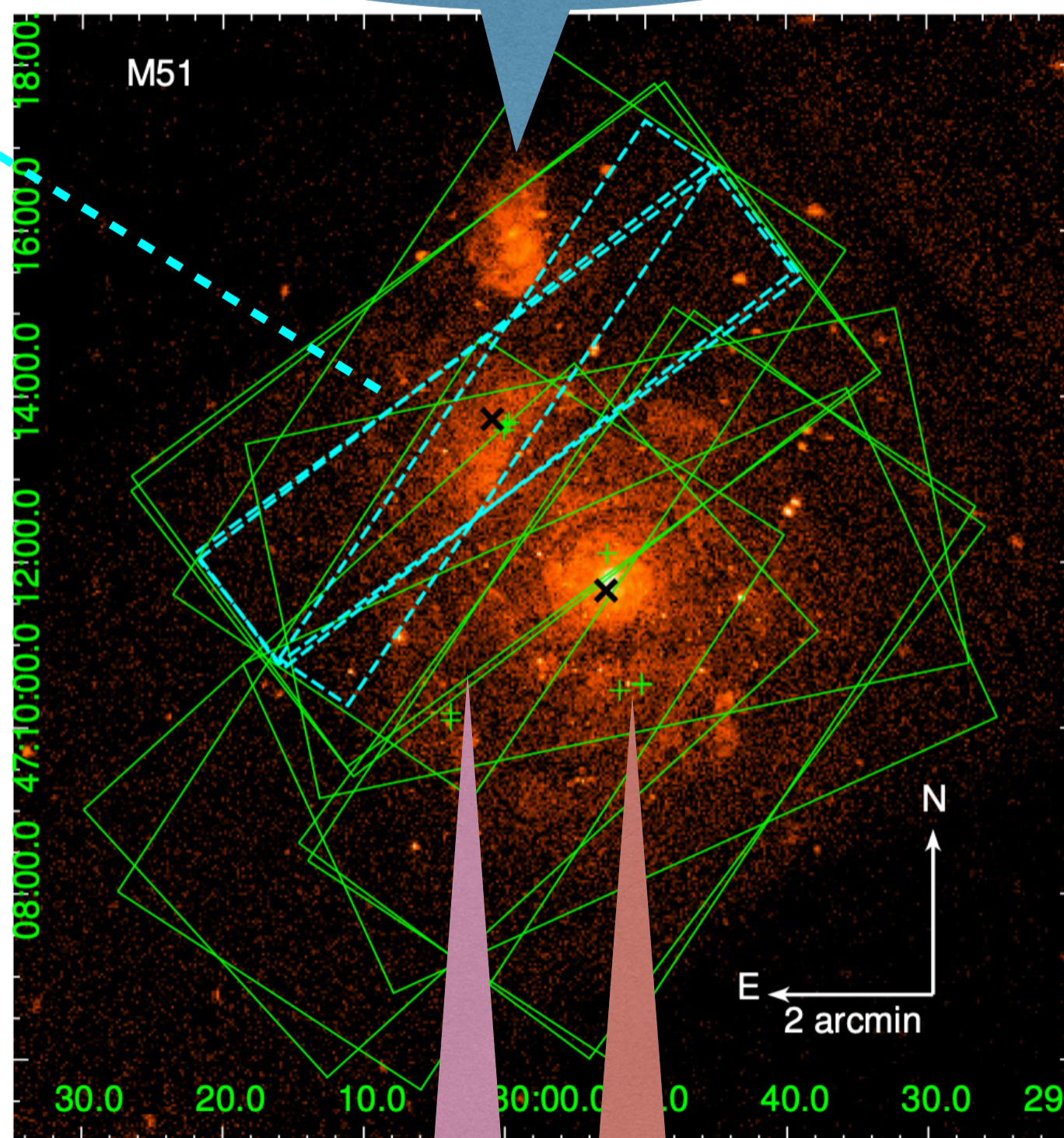
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Galactic fountains operate in outer galaxy disks, where supernovae heat ambient gas to X-ray emission temperatures. However, the diffuse X-ray morphology in the spiral arms is often associated with recent active star formation, instead of supernovae that should be distributed in a more extended region. To better trace the geometry and understand the properties of hot gas in nearby face-on galaxy M51, we extract intensity maps of OVIII and OVII lines based on XMM-Newton/RGS data. The line emission maps are discrepant from each other and from the broad-band X-ray morphology. The stronger emission from OVIII and OVII forbidden lines and the weaker OVII resonance line suggest the prominent contribution from charge exchange (CX) process due to the interaction of hot gas and cold ISM around arms, which is consistent with the spectral modeling of the nuclear and the northern hot spot spectra. Nevertheless, CX is not obvious in the companion galaxy NGC 5195.



NGC 5195 has been gliding past the Whirlpool for hundreds of millions of years. Not interacting with cold gas, no CX.



In the northern hot spot, intense SF is on going. The strong OVIII line dominates in a 0.4 keV plasma. The hot gas is likely expanding and interacting with the neutral gas around, producing the CX emission such as the OVII f line. The OVII f emission is kind of surrounding the OVIII emission, while the r line emission is weak.

The hot gas in the central region has two components: the jet-driven outflow and the diffuse plasma from nuclear star formation. From the line ratios we see clear evidence of CX emission, and from the contour of the OVII f line map we see that the CX is mainly due to the jet-driven outflow interacting with the circum-nuclear medium. The CX contributes ~35% flux in 7-26 Å.

The hot gas outbound dissipates quickly, and its density drops too low to show clear thermal emission such as OVIII line. The arm in the Chandra image is likely dominated by the point sources. No CX too.

Between the grand designed arms, numerous loosely shaped tiny arms interact with the diffuse hot gas and produce CX emission. Where the X-ray emission would be more bright is called by the cold gas.