

Uncovering the gas content of galaxies with Apertif

Helga Dénes and the Apertif team

Neutral hydrogen (HI) is the most basic building block of galaxies and an excellent tracer of various processes influencing galaxy evolution. So far, large HI surveys were carried out with low-resolution, single-dish telescopes and only a relatively small sample of nearby galaxies was mapped with high spatial resolution. The advancement of new technology, such as **phased-array feeds** on radio telescopes, made it possible to efficiently survey large portions of the sky with interferometric arrays and observe thousands of galaxies in high spatial and spectral resolution. This makes it possible to **study the gas content, kinematics and evolution of large samples of galaxies** in unprecedented detail.

Apertif

One of the new Phased array feed instruments is Apertif (APERture Tile In Focus) on the Westerbork Synthesis Radio Telescope. On the 1st of July 2019 Apertif started survey operations. The Apertif imaging surveys are in the process of **mapping about a quarter of the northern sky between 1130-1430 MHz**. For this, we use ~12 hour pointings with 40 compound beams, which give a field of view of approximately 6 square degrees.

Once the data is taken, the Apercal pipeline (see Robert Schulz's poster) automatically identifies the new data sets, calibrates them, and images them. Apercal produces calibrated uv data, radio continuum and polarisation images, and HI data cubes with a spatial resolution of ~15".

Blind HI detections

Several galaxies were detected for the first time in HI during the 2 weeks of the Science Verification program in May 2019. Here we present a selection of new detections and also some that were previously detected by other telescopes, but unresolved.

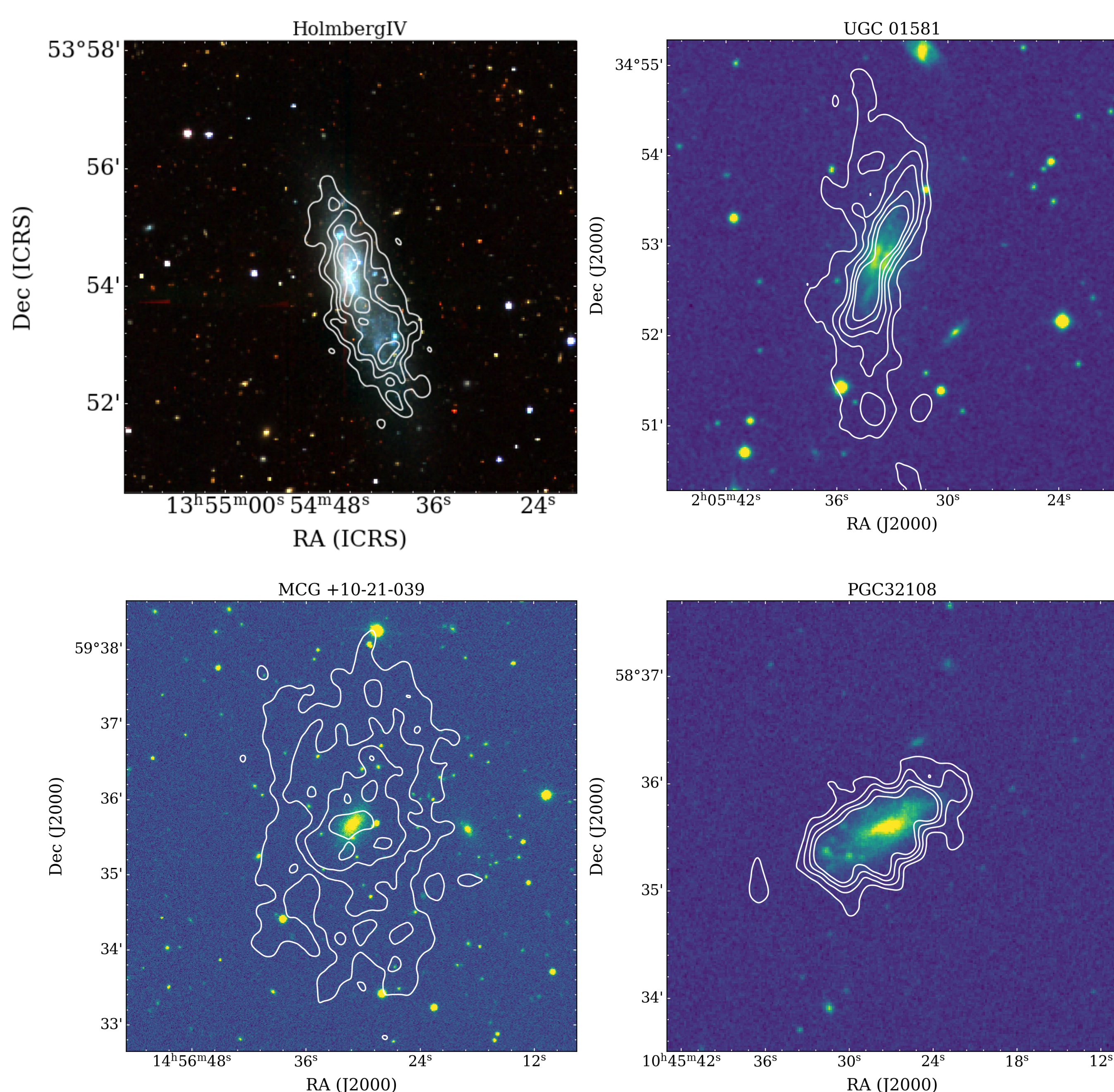


Figure 1: HI contours overlaid on optical images. The rgb image for HolmbergIV is from the DESI Legacy Imaging Survey. The optical images for UGC 01581, MCG +10-21-039 and PGC 32108 are DSS2 B-band images. Contour levels are 2, 3, 4, 5 times the rms of the moment 0 map, except for UGC01581, where the lowest level is the 1 times the rms to show the warped extended disk.

Kinematics

The high spatial and frequency resolution of Apertif makes it possible to study gas kinematics in several hundred galaxies. An example for this is data for PGC 6699. The image on the right shows the velocity gradient across this galaxy, due to the rotation of the gas.

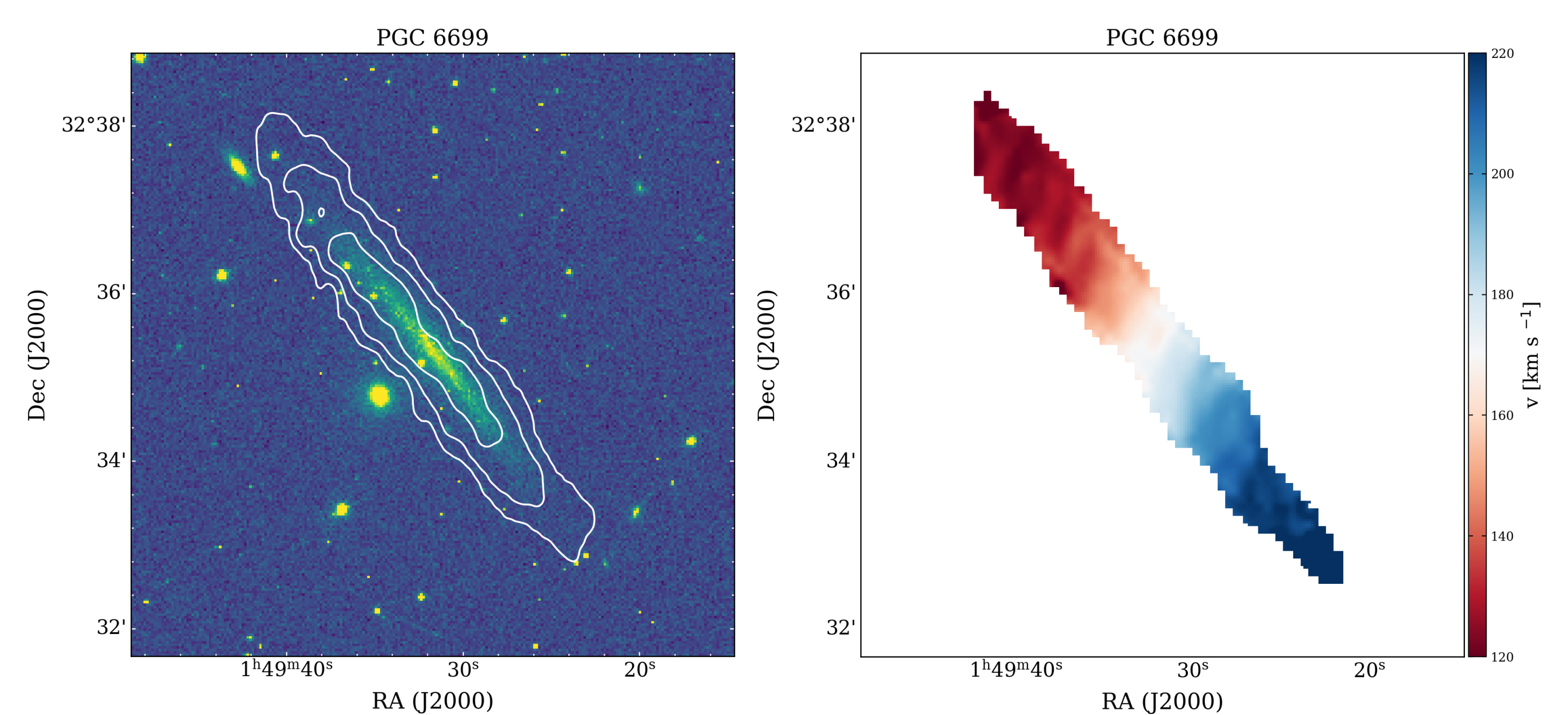


Figure 2: DSS2 B-band image of PGC 6699 with HI contours overlaid. Contour levels are 2, 5, 10 times the rms. The image on the right shows the moment 1 map for PGC 6699.

Tracking galaxy evolution

HI is an excellent tracer of galaxy evolution. An example for this is the new HI image of NGC 5477. This galaxy is part of a galaxy group with a large spiral galaxy nearby. Comparing the HI disk with the stellar disk shows that the HI gas is compressed on one side of the galaxy and elongated on the opposite side. In addition, the elongated HI also corresponds to a faint tail of stars. This morphology indicates either tidal interactions with the other group galaxies or ram pressure stripping in the intra group medium.

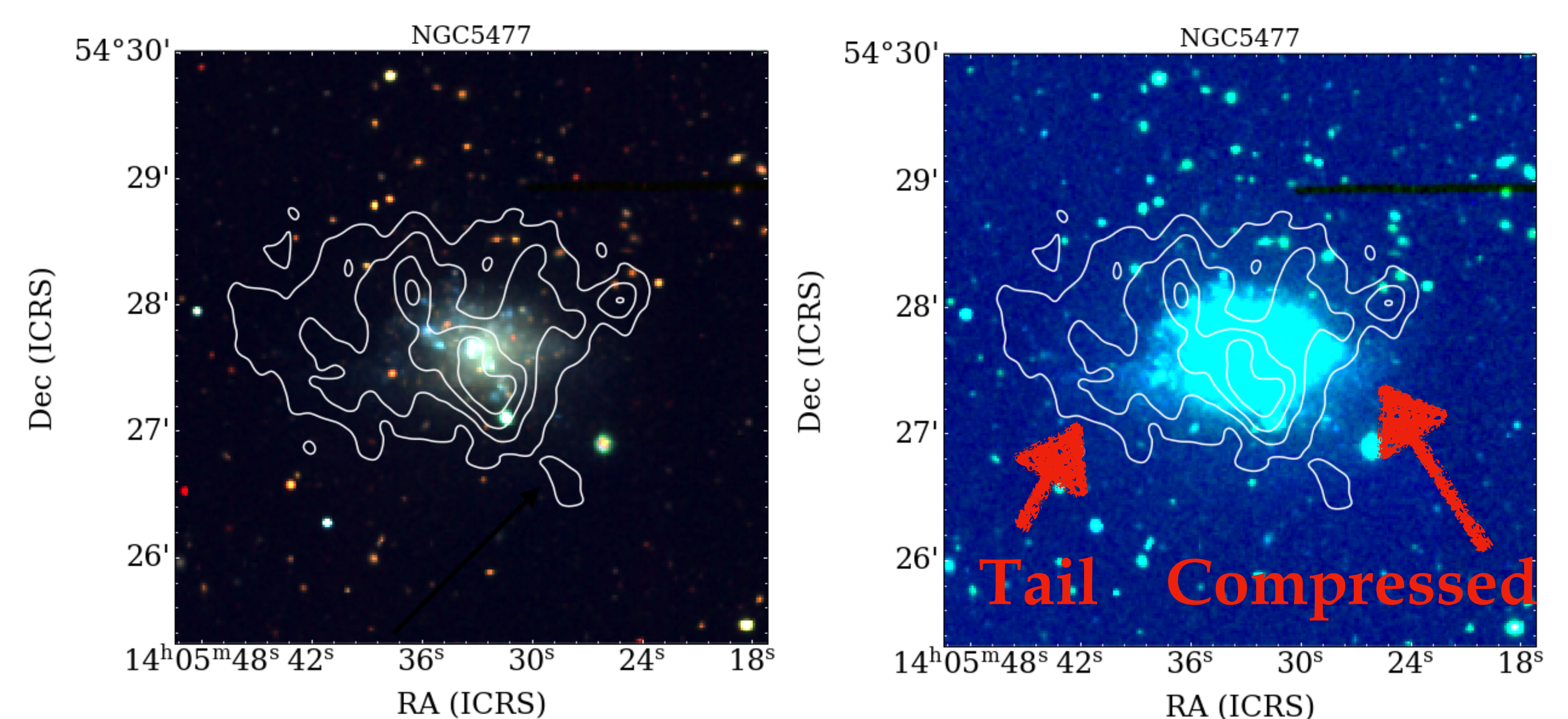


Figure 3: Optical image of NGC 5477 with HI contours over plotted. The optical image is from the DESI Legacy Imaging Survey. The optical image on the right is scaled to highlight the faint, blue emission from young stars. Contour levels are 1, 2, 3, 4 times the rms.

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FURTHER INFORMATION

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