WEAVE-APERTIF

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WEAVE-Apertif

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Apertif is an innovative focal-plane array system on the Westerbork synthesis radio telescope in Dwingeloo that will allow wide-field HI surveys out to cosmological distances (z~0.2). With commissioning expected to finish in late 2017, Apertif will provide radio-source targets to WEAVE for optical follow-up of 100,000 massive gas-rich galaxies in a timely fashion. Apertif is the first working focal-plane array capable of full Westerbork resolution (~15”x15” beam) over a single, full 8 deg^2 pointing. Operating in the frequency range 1000-1750 MHz with nearly the sensitivity of the present single-pixel WSRT frontend. With Apertif, the WSRT can image an area on the sky about 25 times the size of the full moon.

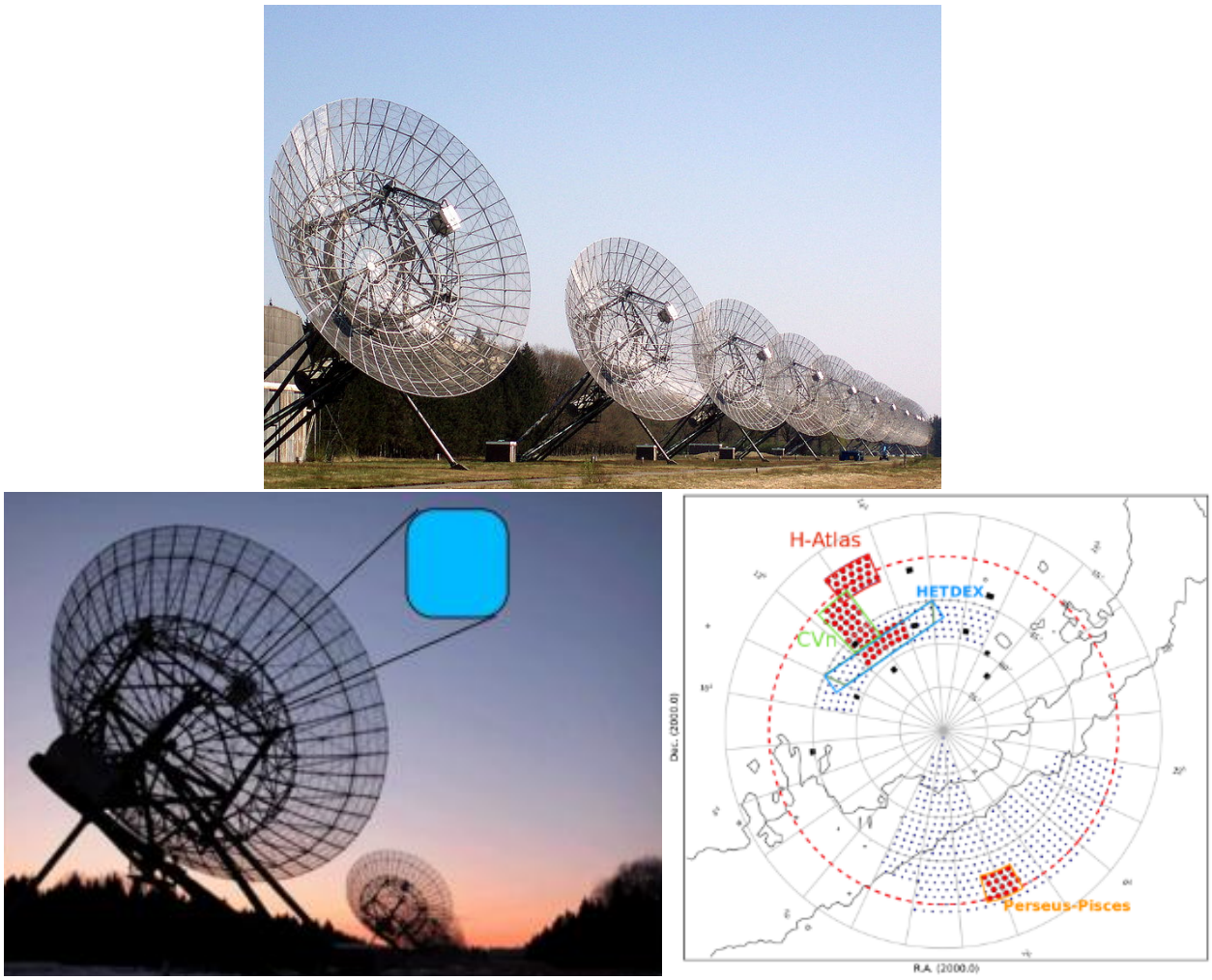


Figure 1. (Left) **View of the Westerbork synthesis radio telescopes in Dwingeloo.** ***(Middle)*** **The area of the sky covered by the new focal-plane array.** ***(Right)*** **The sky coverage of the Apertif survey.**

The current survey program for Apertif calls for a two-tiered imaging survey that will provide strong synergy with WEAVE, comprising a blind medium-deep survey of ~300 deg^2 and a shallow survey of ~3000 deg^2. Both surveys will be largely restricted to the SDSS imaging footprint and to declinations above =+27^o, with an emphasis on surveying the supergalactic plane with its enhanced density of nearby galaxies. The medium-deep survey aims at targeting areas with exhaustive ancillary data such as the HETDEX and Herschel-ATLAS areas, or volumes of particular environmental value such as the nearby CVn group and the Perseus-Pisces supercluster. Together, both surveys are expected to yield ~10^5 HI-detected galaxies of which ~10^4 galaxies will be spatially resolved by Apertif and of those, ~5000 will have optical dimensions that fit the LIFU field-of-view of WEAVE. The Apertif surveys will provide redshifts and the neutral gas content, morphologies, dynamics, and dynamical masses at the resolution described above. Furthermore, Apertif will also detect and measure HI absorption against radio-loud AGN yielding information on gas accretion and outflows, provide spatially-resolved, extinction-free star-formation maps from the radio continuum emission, and identify OH megamasers as locations of intense star formation.

The WEAVE-Apertif survey will be able to harness WEAVE's dual integral-field-unit (IFU) capability, as the large IFU will be ideally suited for large nearby galaxies, while the multiple small IFUs will be perfect for small and distant galaxies. A large-scale integral-field survey with WEAVE creates a strong synergy with the Apertif imaging surveys, significantly increasing the power of each instrument on its own. We will pursue three primary science cases:

The nature of galaxy bimodality

- Why is there a bimodality in galaxy properties today, such that there are both star-forming blue galaxies and red, dead galaxies?
- Where does the gas fueling the star formation in these galaxies come from?
- How is the star formation shut down?

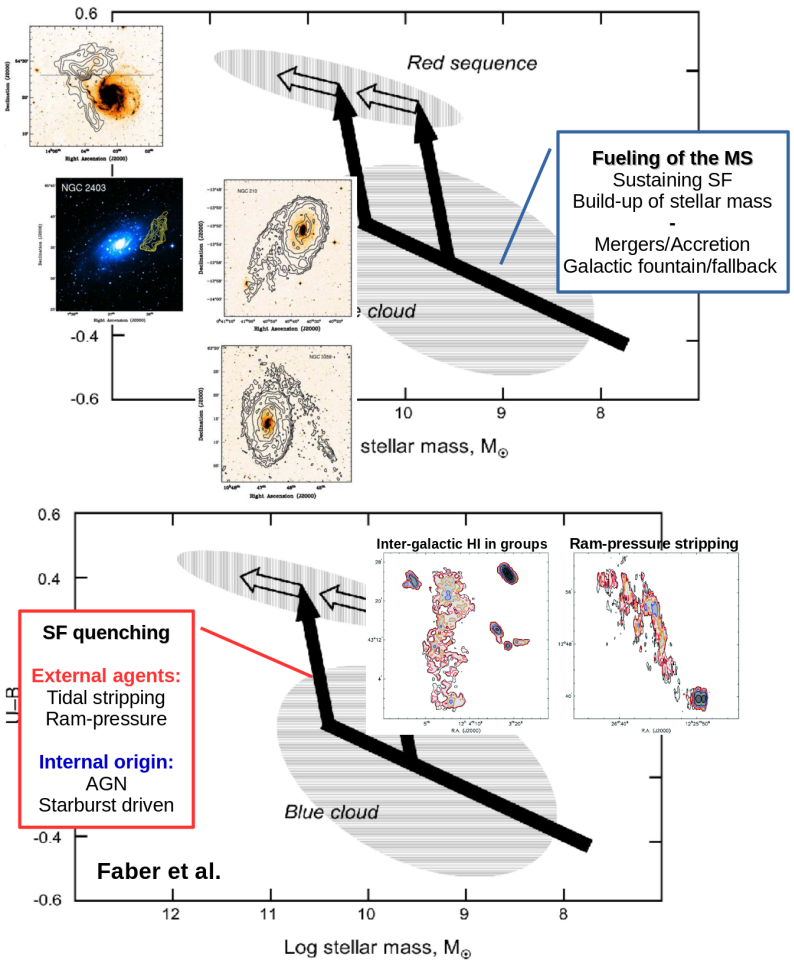


Figure 2. (Left) Type of galaxies in the main star-forming sequence that we are aiming to target with WEAVE-Apertif to understand the mechani replenish the "Blue Cloud". *(Right)* Illustration of galaxies suffering transformations in their way from the star-forming main sequence to the "R

Disk galaxy mass dissection

- How much dark matter do disc galaxies have?
- How is it distributed?

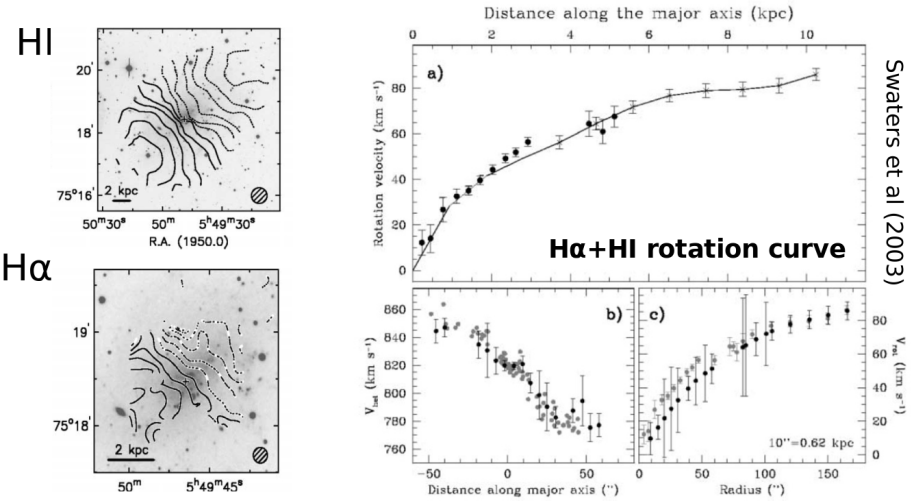
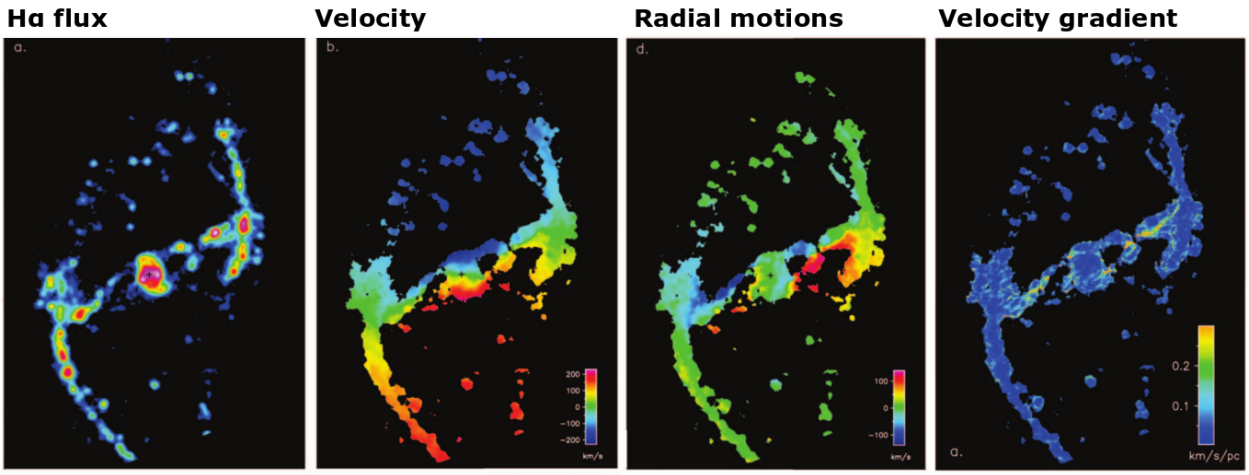


Figure 3. **Illustration of the kind of analysis that will allow us to model the mass profiles of disk galaxies. By mapping both the stellar and gas components to large radii we will be able to determine the baryonic and dark matter content of galaxies.**

Secular evolution of galaxies

- What's the process driving radial migration of stars?
- What's the level of scattering and radial motions induced by spiral arms and bars in stars?
- What's the impact of accretion of satellites in the chemo-dynamical properties of galaxies?
- How does it all connect with observations in the Milky Way?



(Adapted from Zurita et al. (2004)

Figure 4. **Detailed mapping of the velocity fields of the stars and ionized gas in galaxies will help us understand the main processes that drive internal evolution ("secular evolution") in disk galaxies (e.g. radial motions induced by bars, etc...).**

WEAVE-Apertif will study transformations in galaxies by comparing the optical and ISM properties of galaxies transitioning from the main star-forming sequence into the Red sequence. The unique aspect of this survey (compared to other large IFU surveys) resides in the HI selection of targets, which enables the detailed analysis of galaxies in different stages of the transformation process.