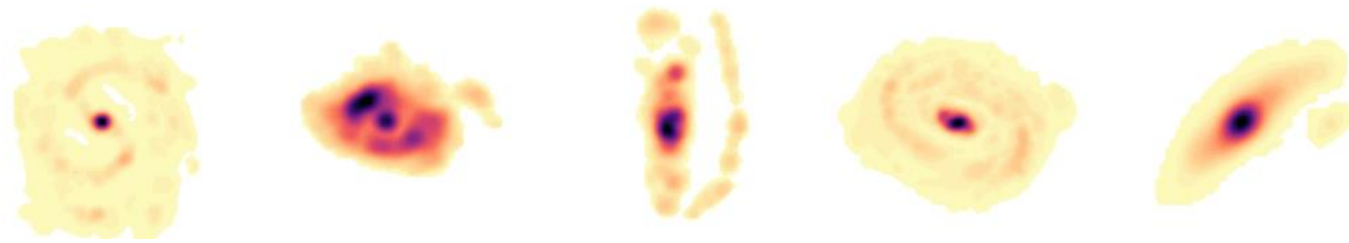


VERTICO is a pioneering large program that will investigate the effect of environment on molecular gas by mapping the **distribution and kinematics of CO(2-1)** in a sample of 51 spiral galaxies in the Virgo Cluster using **ALMA**.

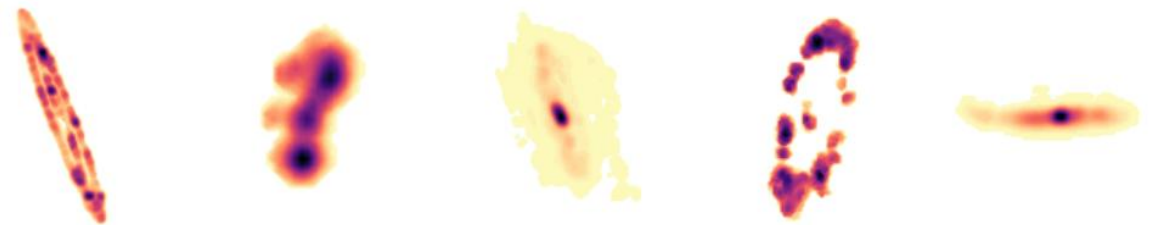
Our deep, high-resolution maps of cluster galaxies' molecular gas content do not exist in current surveys. With these data, VERTICO will open up new avenues of discovery by:

- Quantifying **environmental effects** on the structural and kinematic properties of molecular gas, as well as the atomic-to-molecular gas ratio in Virgo galaxies
- Establishing the star formation rate-molecular gas surface density and dust-to-gas **relationships on sub-kpc scales** throughout the Virgo Cluster

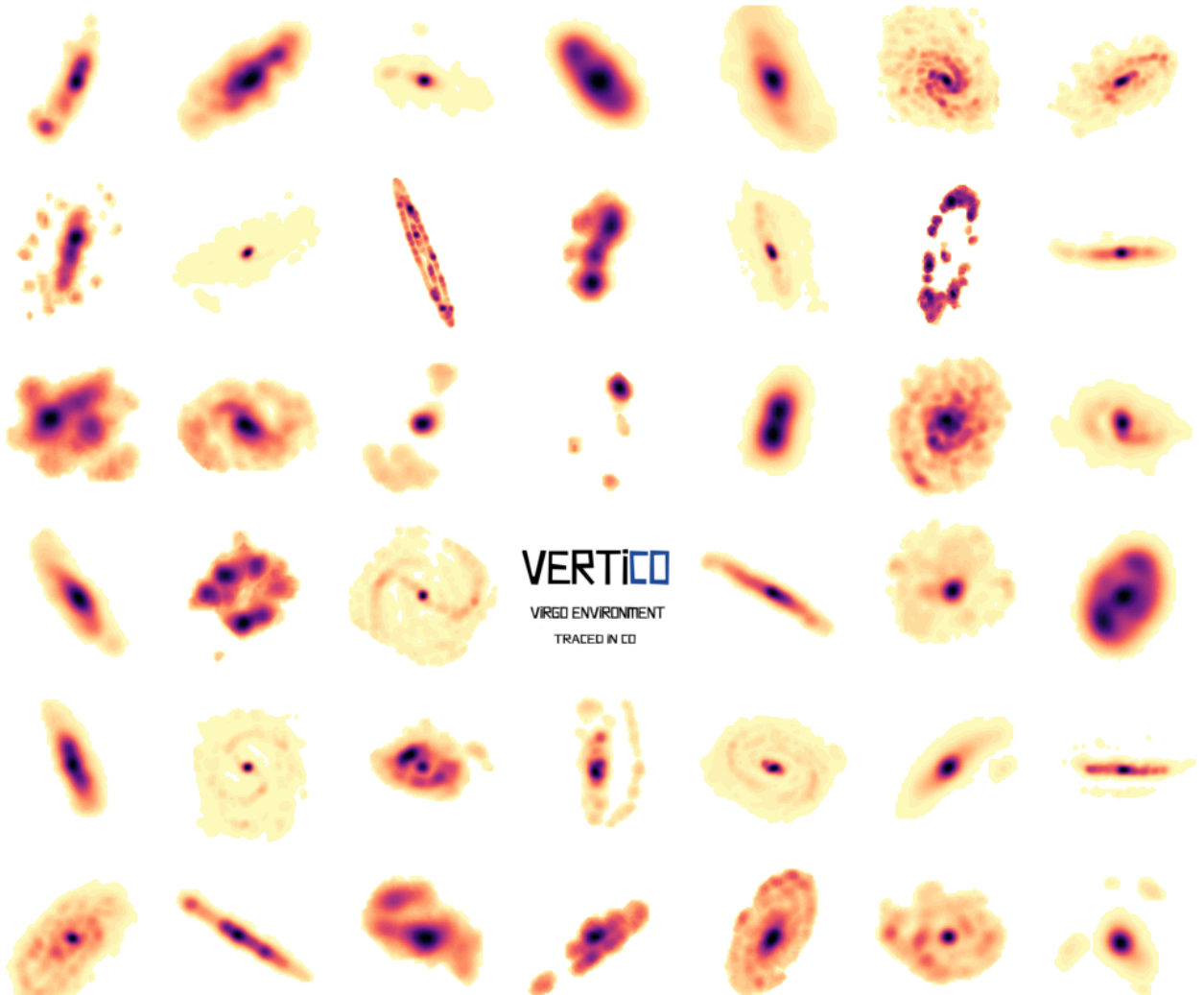


VERTICO

VIRGO ENVIRONMENT TRACED IN CO



Toby Brown (PI, McMaster), Chris Wilson (McMaster), **María Jesús Jiménez (OAN-IGN)**, Dhruv Bisaria (Queens U.), Ian Roberts (McMaster), James Wadsley (McMaster), Kristine Spekkens (Royal Military), Laura Parker (McMaster), Mallory Thorp (Victoria), Ryan Chown (McMaster), Sara Ellison (Victoria), Alessandro Boselli (LA Marseille), Claire Cashmore (U Hull), Elke Roediger (U Hull), Nikki Zabel (Cardiff U), Tim Davis (Cardiff U), Yannick Bahé (Leiden U), Bumhyum Lee (KIAA-PKU), Alberto Bolatto (U Maryland), Angus Mok (U Toledo), Benedikt Diemer (U Maryland), Charlotte Welker (John Hopkins), Karen Pardos Olsen (U Arizona), Stephanie Tonnesen (Flatiron), Stuart Vogel (U Maryland), Vicente Villanueva (U Maryland), Hyein Yoon (Yonsei U), Rory Smith (KASI), Aeree Chung (Yonsei U), Adam Stevens (UWA), Barbara Catinella (UWA), Claudia Lagos (UWA), Luca Cortese (UWA), Pascal Elahi (UWA)



Galaxy evolution is driven by two main factors:

- Secular, passive evolution, primarily governed by the system's dynamical mass.
- External **influence from the environment** in which the galaxy resides.

VERTICO aims to answer the questions:

1. What is the dominant mode of environmental influence on galaxies?
2. How do environmental factors affect the conversion of gas into stars?
3. Is the process of star formation universal across different environments?

How? By measuring the resolved structural, kinematic, and physical properties of molecular gas as a function of other ISM and galaxy properties over the full diversity of environmental mechanisms and densities.

The Vertico Sample: 51 galaxies in Virgo

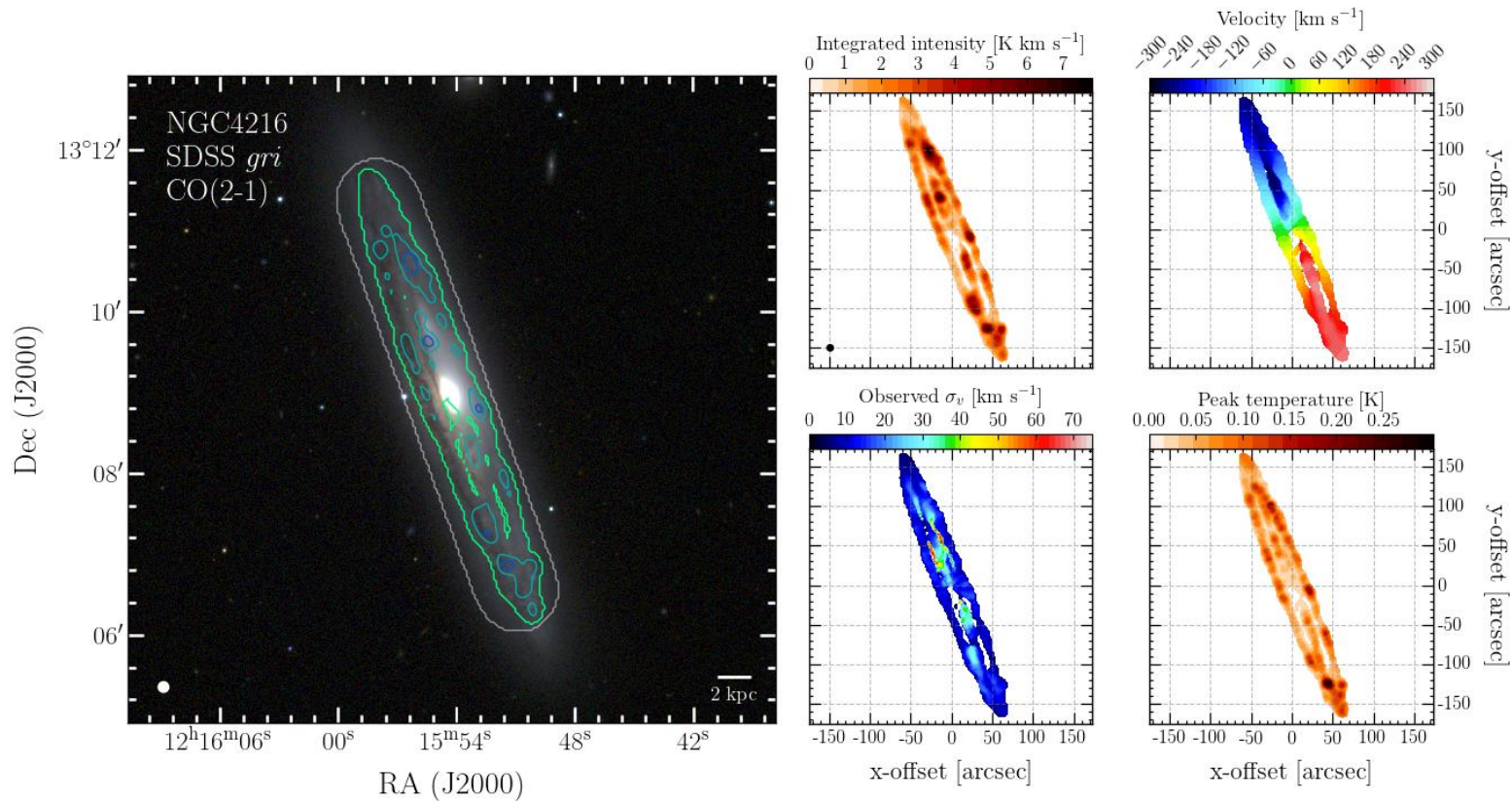
- New large program obtained in **Cycle 7** (2019-2020, PI Brown): 36 galaxies, combination of 7m+TP (total power).
- **PHANGS** (Leroy+inprep) archival data: pilot (2015-2016) and large programs (2017-2019): 14 galaxies with 7m+TP.
- Other **archival** data (PI. J Kenney): 1 galaxy, 7m data only.



Brown et al. inprep

The Vertico Data: Band 6 @ 0.5kpc

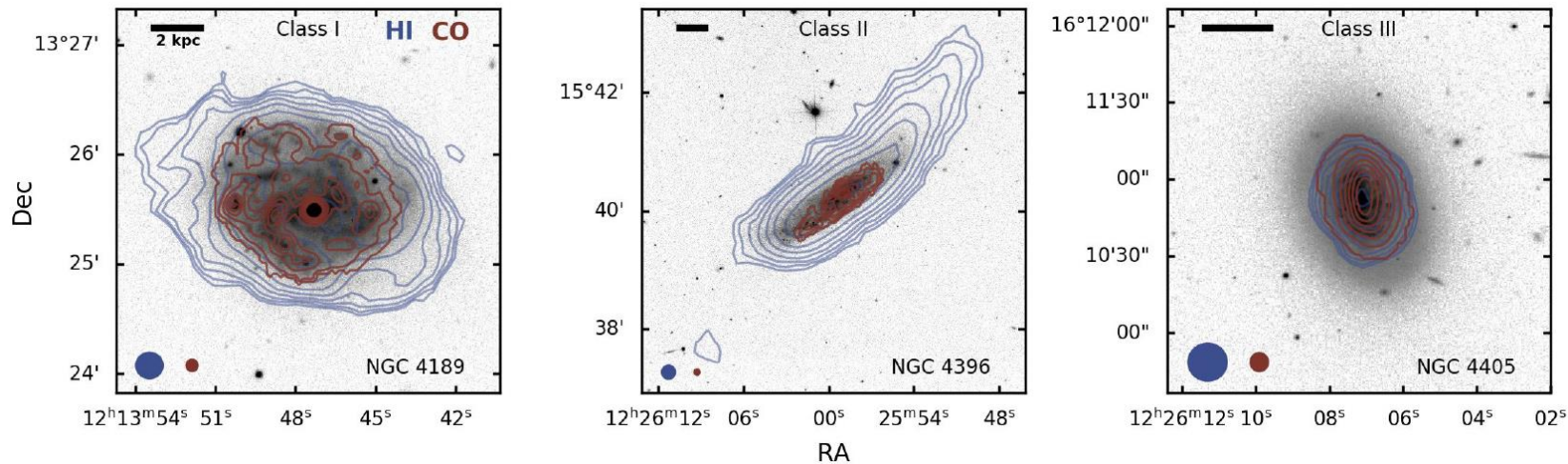
- J=2-1 lines of ^{12}CO , ^{13}CO , C18O, and 1.3 mm continuum.
- Each galaxy has standard products:
 - ✓ Processed data cubes
 - ✓ Molecular gas surface density maps
 - ✓ Kinematics
 - ✓ Spectral information



First round of science: asymmetries & quenching



Are asymmetries observed in HI also present in CO? What is the distribution of galaxies as a function of CO asymmetry within Virgo?

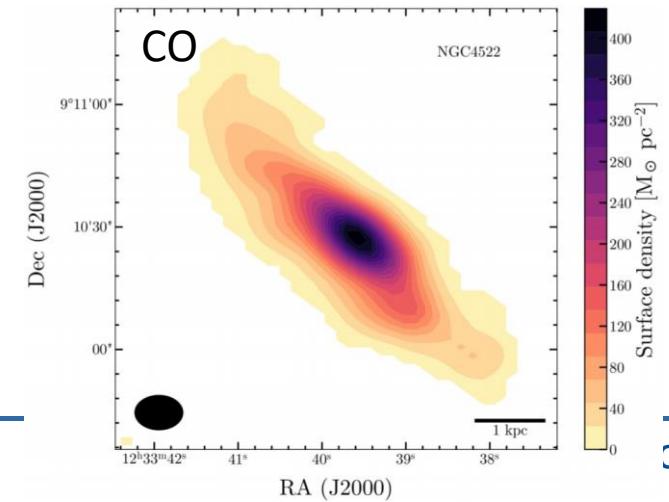
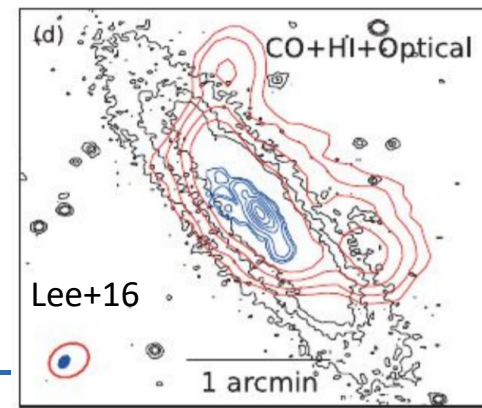


Roberts et al. in prep.

- Galaxies with HI tails show high CO asymmetries
- Enhanced CO emission on the leading edge seems to be present in many stripping galaxies

How do quenching mechanisms affect the molecular gas? Do they result in deficiencies, asymmetries, truncation or disturbed kinematics?

Zabel et al in prep.



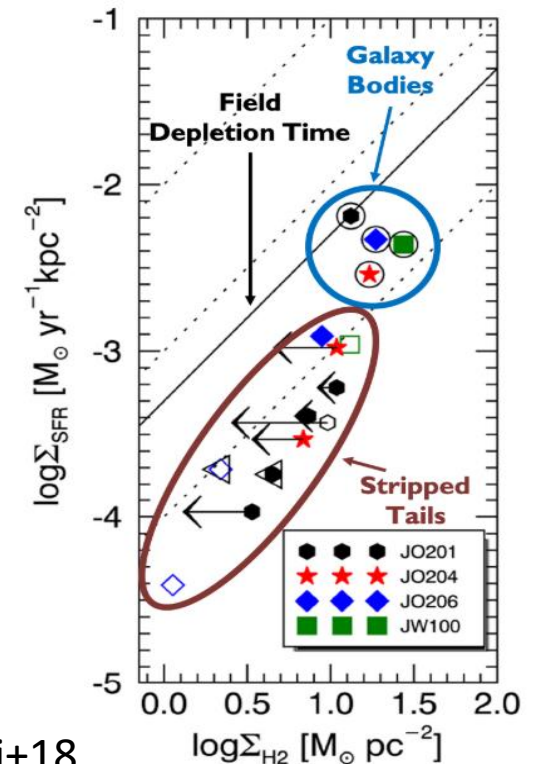
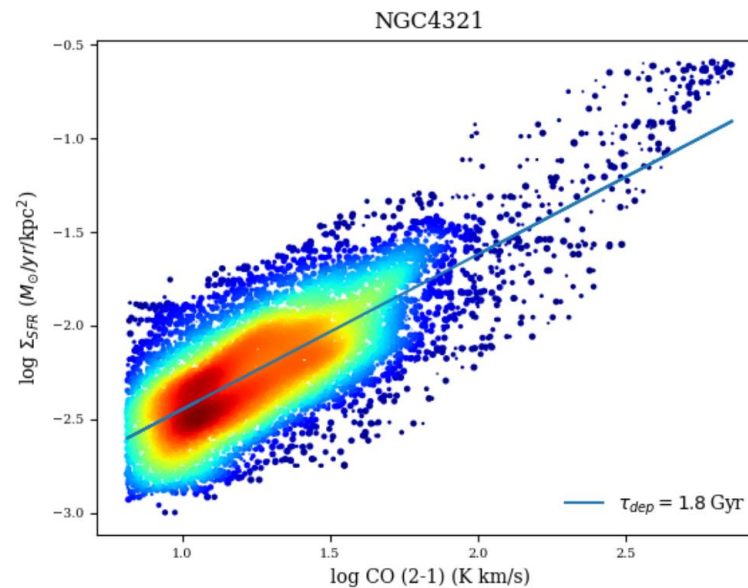
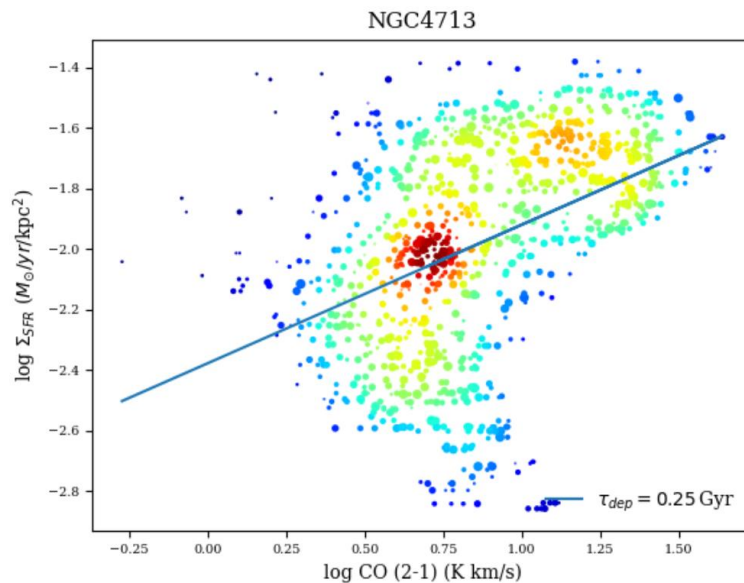
First round of science: Global vs. individual Kennicutt-Smith relation



How does *SFR* depend on molecular gas content? How is **local-scale** (sub-kpc) SF efficiency connected to the **large-scale** (Mpc) environment?

What drives the **observed variations in SFE** in these different environments?

Jiménez Donaire et al. in prep.



Moretti+18

Summary & Future Prospects

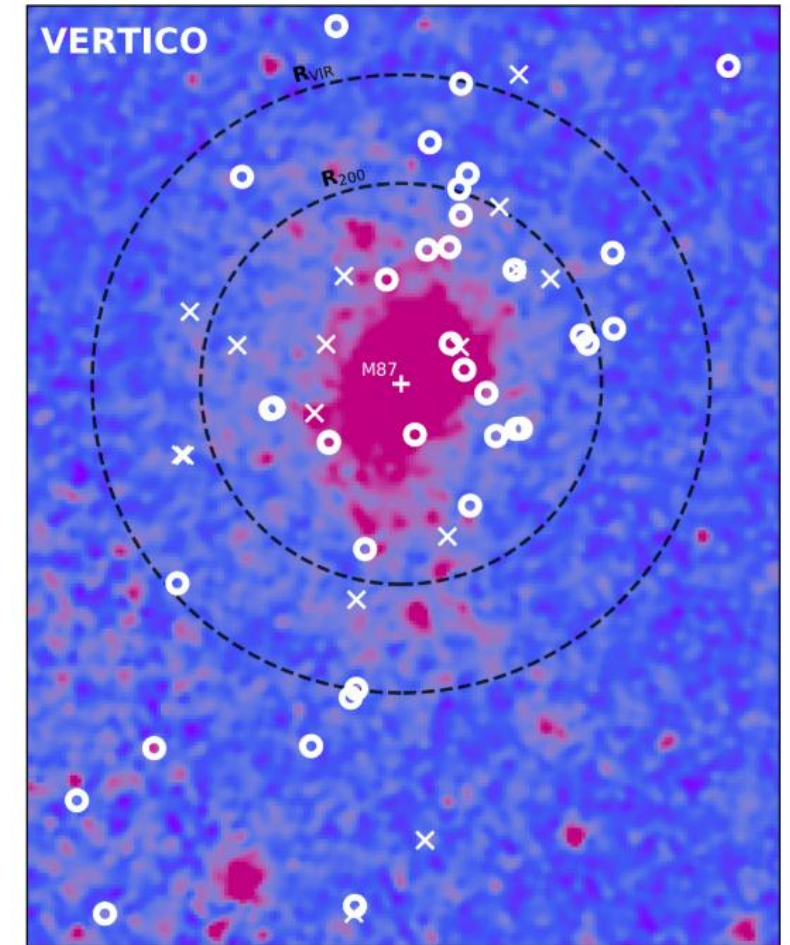
VERTICO will reveal the physical mechanisms that drive galaxy evolution in dense environments in unmatched detail, and provide the critical final component of a **diverse, homogeneous** legacy data set for studying galaxy evolution science in the closest galaxy cluster.

Current status:

- Pipeline processed data for 50 galaxies, with high quality multi-wavelength data products, including SFR and stellar mass maps and centralized SQL database.
- Work underway on **five first-round science papers**, started nine more papers, with strong leadership by graduate students.

Our preliminary results already show that external processes alter the molecular gas distribution, its symmetry, and influences the star formation efficiency in the distinct galaxy environments.

Stay tuned for more!!!



Smoothed ROSAT X-ray all-sky survey image of the hot Virgo Cluster ICM. White circles (Cycle 7) and crosses (ancillary) make up VERTICO.