# Cold gas content in galaxies around the Virgo cluster

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**Résumé**

The key components of galaxies are their cold gas content, which acts as fuel for star formation. At the same time, one of the main elements regulating the evolution of galaxies is their environment. A number of physical processes (e.g. ram-pressure stripping, tidal interactions, etc.) can significantly affect the properties of galaxies residing in different environments. Using a unique combination of information on the mass of cold gas (both atomic HI and molecular H2) for galaxies in the Virgo cluster and in the surrounding filaments, we study the influence of the environment on regulating the gas content of galaxies in and outside clusters, low-mass groups, and filamentary structures.. We complement the observational analysis with a comparison to predictions from the Galaxy Evolution and Assembly (GAEA) semi-analytic model, which has explicit prescriptions for partitioning the cold gas content in its atomic and molecular phases. We show that galaxies within filaments divide into two populations: those found in groups and those found in solated galaxies, which have gas properties similar to galaxies in a field. We also show how the distance to the filament axis or the halo mass affects the gas deficit in galaxies.

**Mots-Clés:** galaxy evolution, gas content, environment, galaxy cluster, Virgo cluster

*Intervenant

# Investigating the intracluster medium viscosity using the tails of jellyfish galaxies

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**Résumé**

The microphysics of the intracluster medium (ICM) in galaxy clusters is still poorly understood. Observational evidence suggests that the effective viscosity is suppressed by plasma instabilities that reduce the mean free path of particles. Measuring the effective viscosity of the ICM is crucial to understanding the processes that govern its physics on small scales. The trails of ionized interstellar medium left behind by the so-called jellyfish galaxies can trace the turbulent motions of the surrounding ICM and constrain its local viscosity. We present the results of a systematic analysis of the velocity structure function (VSF) of the H$\alpha$ line for ten galaxies from the GASP sample. The VSFs show a sub-linear power law scaling below 10 kpc which may result from turbulent cascading and extends to 1 kpc, below the supposed ICM dissipation scales of tens of kpc expected in a fluid described by Coulomb collisions. Our result constrains the local ICM viscosity to be 0.3-25% of the expected Spitzer value. Our findings demonstrate that either the ICM particles have a smaller mean free path than expected in a regime defined by Coulomb collisions, or that we are probing effects due to collisionless physics in the ICM turbulence.

**Mots-Clés:** intracluster medium, MUSE

*Intervenant

# MAGIC: a unique survey to probe the role of environment on galaxy assembly

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**Résumé**

The MAGIC (Muse gAlaxy Groups In Cosmos) survey, a 100h MUSE-GTO program, was built to improve our understanding of the impact of environment on galaxy evolution, taking advantage of the large MUSE FoV that matches well the size of groups at intermediate redshift. It targets 14 massive groups identified in the COSMOS field at 0.3

**Mots-Clés:** Galaxy evolution, Groups and clusters, Deep surveys

*Intervenant

# ESO 137-001: a jellyfish galaxy model

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**Résumé**

Ram-pressure stripping of the spiral galaxy ESO 137-001 within the highly dynamical intracluster medium of the Norma cluster lead to spectacular extraplanar CO, optical, Halpha, UV, and X-ray emission. The Halpha and X-ray tails extend up to 80 kpc from the galactic disk. I will present dynamical simulations of the ram-pressure stripping event, where the physics of the stripped gas and its ability to form stars are studied. The modeling of the Halpha emission caused by ionization through thermal conduction is consistent with observations. We predicted the HI emission distributions for the different models, which can be compared to the recently published MeerKAT observations. Based on the 3D velocity vector derived from our dynamical model, we derive a galaxy orbit, which is close to unbound.

**Mots-Clés:** ESO 137, 001

*Intervenant

# Radio-dim and bright regions in cluster spiral galaxies

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**Résumé**

One of the tightest correlations in astronomy is the relation between the integrated radio continuum (synchrotron) and the FIR emission. It holds over five orders of magnitude in various types of galaxies including starbursts. The common interpretation of the correlation is that both emission types are proportional to star formation. Radio continuum emission can act as a tracer for the star formation rate with the added advantage over other tracers that it is unaffected by dust attenuation.
The relation between the resolved star formation rate per unit area and the nonthermal radio continuum emission was studied in 21 Virgo cluster galaxies and the two nearby spiral galaxies, NGC 6946 and M 51. Based on the linear correlation between the SFR per unit area and the synchrotron emission and its scatter, radio-bright and radio-dim regions can be robustly defined for our sample of spiral galaxies. For the interpretation and understanding of our results, we used a 3D model where star formation, 2D cosmic-ray propagation, and the physics of synchrotron emission are included.
I will discuss the physical causes of radio-dim and bright regions and relate them to the interaction of the galaxy with the cluster environment.

**Mots-Clés:** cluster spiral galaxies, radio continuum emission

*Intervenant

# ALMA JELLY - Survey of Nearby Jellyfish and Ram Pressure Stripped Galaxies

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**Résumé**

The ALMA JELLY project observed a sample of 28 jellyfish galaxies with extended multiphase and star forming tails in the nearby clusters Coma, Leo and Norma. This constitutes the first systematic and homogeneous survey of the molecular component of ram pressure stripped galaxies. The sample galaxies cover a range of evolutionary stages of stripping, from early with tails connected to star-forming disks, to late with detached tails and passive or post-starburst disks. We will present the results of the ALMA JELLY survey, focusing on the incidence and properties of the molecular component of the sample galaxie.

**Mots-Clés:** galaxy evolution, galaxy cluster, jellyfish galaxy, intracluster medium, interstellar matter, molecular gas

*Intervenant

# HI view of ram pressure stripping

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**Résumé**

I will present a number of recent results on the evolution of galaxies in clusters with a focus on resolved HI imaging. As part of the MeerKAT Fornax Survey, we are finding that HI rich first infallers into Fornax (a very small cluster) undergo a two-step interaction: first, tidal interaction move gas to large radius; second, the weak ram pressure of Fornax is able to further displace the HI and strip it from the galaxy. As part of GASP, we found evidence of an enhanced star formation rate per unit HI mass in both the discs and tails of optically selected jellyfish galaxies, and I will show a similar result for Coma. As part of the MeerKAT Galaxy Cluster Legacy Survey, we are studying the statistical relation between HI-sleected and optically-selected jellyfish galaxies. Finally, I will show first results from the ViCTORIA survey of Virgo. I will discuss what we can expect from current and future HI surveys for the study of ram pressure stripping.

**Mots-Clés:** HI

*Intervenant

# Ram-pressure stripping in Coma cluster as a driver of dwarf galaxy evolution

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**Résumé**

Galaxy clusters are the largest gravitationally bound structures in the Universe. Numerical simulations provide detailed scenarios on how they assemble and evolve over the lifetime of the Universe, but observational evidences supporting these predictions are still elusive. Galaxy populations in nearby clusters are dominated by dwarf stellar systems, and the number of these galaxies continues to grow over time even at the present epoch.Over the last 5 years, using MMT Binospec we collected a rich spectroscopic dataset, which comprises over 250 dwarf early-type galaxies in three massive nearby clusters: Coma (D=99 Mpc), Abell 2147 (D=165 Mpc), and Abell 168 (D=193 Mpc). We have also reduced and analyzed spectra of dwarf galaxies in the Virgo cluster (D=16.5 Mpc) publicly available in the Keck, Gemini, and VLT data archives. These spectroscopic datasets were complimented by re-reduced archival deep optical images from Subaru HSC and CFHT MegaCam instruments where we used our own sky background modeling technique that allows to achieve an accurate background subtraction. For every galaxy we have a spatially resolved optical spectrum reaching up to 1-2 half-light radii from its center that was used to obtain their internal properties, such as stellar kinematics, ages and chemical composition of their stars and perform Jeans dynamical modelling, which yields dark matter content and dynamical masses. Profiles of radial velocity for a dozen of dEs in the Coma cluster demonstrate quite a large fraction of kinematically decoupled cores suggestive of relatively recent mergers. These datasets allow us to consider several various scenarios of dE galaxy formation and evolution and put them in correspondence with different dE sub-classes. With these data we can directly test the applicability of the abundance matching to galaxies in clusters in the 3x10ˆ8–5x10ˆ9 MSun range in stellar mass.

**Mots-Clés:** ram pressure stripping, dwarf galaxies

*Intervenant

# Study of CO(3-2)/CO(2-1) line ratio in the disk and tail of prototypical jellyfish galaxy ESO 137-001

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**Résumé**

Galaxies in rich galaxy clusters are experiencing various environmental processes that significantly affect their evolution, gas content, and star formation. In jellyfish galaxies, ram pressure exerted by hot intra-cluster medium (ICM) efficiently strips the cool, star-forming interstellar matter (ISM) from the galaxy's disks, forming (in some cases long) gaseous tails trailing behind the galaxy. ESO137-001, a jellyfish galaxy in nearby Norma cluster, has a prominent 80kpc-long stripped tail, with multi-phase gas observed in CO, HI, radio continuum, Halpha, and X-rays.
We study the distribution of molecular gas in ESO137-001 using yet unpublished CO(3-2) data in combination with archival CO(2-1) data from ALMA. By analysing the CO(3-2)/(2-1) line ratios, we explore the excitation conditions and physical properties of molecular gas. Additionally, we study how these properties vary across different regions of the galaxy, from the disk to the first 20kpc of the tail.

**Mots-Clés:** jellyfish galaxies, CO(3, 2)/CO(2, 1) ratio, cold gas, ALMA

*Intervenant

# Hydrodynamical simulation for NGC4569

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**Résumé**

The massive galaxy NGC4569 in the Virgo cluster is one of the best examples of a galaxy undergoing a ram pressure stripping event, as suggested by a large amount of multi-frequency data.
To provide a comparison with a simulated counterpart, I am analysing an ad-hoc hydrodynamical simulation of a galaxy with the same parameters. This simulation is specifically tuned to distinguish various gas phases (ionised, molecular, and cold atomic gas), allowing us to follow the different gas removal phases in the ram-pressure stripping process.
This comparison will allow us to study closely if hydrodynamical simulations are able to account precisely for ram pressure tails and to study how the galaxy components change over time due to this process.

**Mots-Clés:** hydrodynamical simulation, NGC4569, gas phases

*Intervenant

# Ram pressure stripping in the local universe

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**Résumé**

The study of multifrequency surveys targetting different environments has shown the presence of galaxies suffering ongoing perturbations able to remove their gaseous content and quench their activity of star formation. These perturbing mechanisms can be divided in two main families, gravitational and hydrodynamic. The former act indifferently on all the baryonic components, the latter only on the gas component, with different effects on galaxy evolution. There are several examples where these mechanisms act together, with peculiar effects on the gaseous and stellar distributions of the perturbed systems. I will briefly review the most recent results gathered from the analysis of multifrequency data of local clusters and groups, stressing how the identification of a dominant perturbing mechanism can be incorrect whenever a single set of data is used in the analysis.

**Mots-Clés:** Environmental effects on galaxy evolution

*Intervenant

# The Fate of Infalling Galaxy Groups: Insights from The300 project

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**Résumé**

Clusters grow by accreting galaxies from the cosmic web. To understand the evolution of cluster galaxies, it is crucial to disentangle their past environmental histories from the final stages of their interaction with a rich intracluster medium. Some galaxies fall in directly from the field after a long period of secular evolution. Others are funnelled along filaments, or enter as members of a previously bound group. In this talk, I focus on the dynamics and structure of galaxy groups as they interact with large clusters. The group environment may contribute to pre-processing of galaxy properties prior to cluster accretion by stripping gas or enhancing merger rates, and these evolutionary processes can be enhanced even further when a group enters a cluster. Using a suite of 324 zoom-in hydrodynamical resimulations of massive clusters from TheThreeHundred project, we analyse 1,340 infalling groups (Haggar et al. 2023). We find that most groups do not survive cluster infall-half of their galaxies become unbound by first pericentre. Slow-moving galaxies near the group centres are particularly prone to tidal disruption or mergers. Moreover, the vast majority of groups entering a cluster are doing so for the first time. Our findings have significant implications for observational studies, where a single snapshot cannot easily reveal past orbital history. However, we suggest that groups observed just outside a cluster are unlikely to have previously experienced a cluster environment.

**Mots-Clés:** cluster assembly, simulations, groups, galaxy evolution

*Intervenant

# A group of merging galaxies falling onto Abell 2142

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**Résumé**

Galaxy clusters grow hierarchically by accreting galaxies, both individually and in groups. While simulations suggest that around 12% of infalling galaxies arrive as part of groups, observational studies of such systems during cluster infall remain rare. I will be presenting a case study of a galaxy group accreting into Abell 2142, notable for a 700 kpc long X-ray tail indicative of ram-pressure driven gas stripping. Using MaNGA integral field spectroscopy, we analyze the stellar populations, ionized gas kinematics, and star formation activity of the group's galaxies, distinct from the tail itself. Our analysis reveals disturbed gas kinematics and suppressed star formation in the group members, consistent with preprocessing mechanisms such as tidal interactions and ram pressure. Complementary radio continuum observations show no detections in the tail, suggesting a lack of strong AGN activity or bright synchrotron emission, though the absence of a detection warrants further investigation. Archival GALEX UV data hints at diffuse emission in the tail region, meriting further analysis. This study highlights how group environments alter galaxies before cluster entry, with MaNGA's spatially resolved data uniquely tracing the interplay of gas and stellar evolution. These observations provide critical insights into hierarchical cluster growth and the role of preprocessing in quenching galaxies.

**Mots-Clés:** galaxy groups, ram, pressure stripping, cluster

*Intervenant

# Untangling UDG_˜32 from the stripped filaments of NGC3314A in the Hydra I cluster

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**Résumé**

In this talk, I would like to present the intriguing case of the ultra-diffuse galaxy named UDG32, a Hydra I cluster member. This object was discovered in the extended network of stellar filaments of the jellyfish galaxy NGC 3314A. This galaxy is affected by ram pressure stripping and it is hypothesised that UDG32 may have formed from this stripped material. Using the MUSE data from the ESO large program "*Looking into the faintest with MUSE (LEWIS)*", we confirm that UDG32 is part of the same kinematic structure as NGC 3314A. In addition, we confirmed that the stripped material from NGC 3314A, traced by emission lines such as H$\alpha$, extends much further from its parent galaxy than previously known, completely overlapping with UDG32 in projection, and with ram pressure-induced star formation. Using multi-band data, we constrained the age and metallicity of UDG32, and we found that metal-rich and intermediate-age nature of UDG 32 points towards its formation from pre-enriched material in the south-east group of the Hydra I cluster that was liberated from a more massive galaxy via tidal or ram-pressure stripping. Results are recently published in A&A by Hartke, Iodice et al. in 2025.

**Mots-Clés:** galaxies: individual: UDG 32, galaxies: individual: NGC 3314A, galaxies: clusters: Hydra I – galaxies: formation

*Intervenant

# Inner Tail Gas Asymmetries and Fallback in the Jellyfish Galaxy NGC 4858

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**Résumé**

Gaseous evolution due to ram pressure acceleration of material that has been pushed out of the disk, but not fully stripped, can be a complex process. We explore this "inner tail" evolution using high-resolution (∼1" = 460pc) ALMA CO(2-1) observations of the Coma cluster jellyfish galaxy NGC 4858, obtained from the ALMA-JELLY large program. We compare this spectacular observational data to a suite of state of the art ENZO "wind tunnel" galaxy simulations, where we vary the disk-wind angle between runs. In our observations, we find numerous structural and kinematic features indicative of the effects from strong, inclined ram pressure, including an asymmetric inner gas tail. We also find kinematic signatures of fallback: gas clumps that had been previously pushed out of the disk but are now falling inwards. We propose a simple, torque-focused mechanism that would create asymmetric inner-tail morphologies regardless of the presence of pre-existing spiral structure. These asymmetries are supported by the results of our simulation suite which also confirm where fallback is to be expected based on the galaxy's rotation and the ram pressure wind direction. We find that while fallback occurs in all simulations more inclined than 45 degrees, the fallback rates are largest for angles closer to edge-on. We also find that star formation is elevated for more inclined winds, and can lead to the generation of a "leading edge plume": shell-like structures of stars upstream from the galaxy disk.

**Mots-Clés:** jellyfish galaxies : galaxy simulations :

*Intervenant

# Ram-pressure stripping of galaxy groups falling onto massive clusters

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**Résumé**

At present times, the peak of the halo mass density occurs at the scale of galaxy groups, i.e. dark matter halos with a mass on the order of 1e13 solar masses. As such, the most massive galaxy clusters in the Universe, which represent the culmination of the structure formation process, gather a large fraction of their mass through the successive accretion of group-scale halos. During the infall, the gaseous content of the infalling groups gets stripped from its original halo by the ram pressure of the surrounding hot ICM, which can lead to Mpc-long gas trails opposite to the direction of motion. In the framework of an observing program dedicated to the deep X-ray mapping of a set of 13 galaxy clusters out to their virial radius, we discovered several spectacular examples of ram-pressure stripping of galaxy groups, which provide invaluable insights on the growth of structure process at present times and allows us to study in detail the impact of the hot ICM on the denser and cooler group atmosphere. I will present the results of deep observations of these systems and what we have learned from them on the virialization of infalling material.

**Mots-Clés:** galaxy groups, hot gas, ram, pressure stripping, growth of structures

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