Ionized gas disks in Elliptical and S0 galaxies at $z < 1$

Yara L. Jaffé[1⋆], Alfonso Aragón-Salamanca[2], Bodo Ziegler[3], Harald Kuntschner[4], Dennis Zaritsky[5], Gregory Rudnick[6], Bianca Poggianti[7], Carlos Hoyos[2], Claire Halliday[8], Ricardo Demarco[1].

[1] *Department of Astronomy, Universidad de Concepción, Casilla 160-C, Concepción, Chile*
[2] *School of Physics and Astronomy, The University of Nottingham, University Park, Nottingham NG7 2RD, UK*
[3] *University of Vienna, Department of Astrophysics, Türkenschanzstr. 17, 1180 Wien, Austria*
[4] *European Southern Observatory, Karl-Schwarzchild Strasse 2, 85748 Garching, Germany*
[5] *University of Arizona, 933 N. Cherry Ave, Tucson, AZ 85721, USA*
[6] *The University of Kansas, Department of Physics and Astronomy, Malott room 1082, 1251 Wescoe Hall Drive, Lawrence, KS, 66045, USA*
[7] *Osservatorio Astronomico, vicolo dell Osservatorio 5, I-35122 Padova Italy*
[8] *23, rue d'Yerres, 91230 Montgeron, France*

(arXiv:1403.3104, accepted in MNRAS)

ABSTRACT

We analyse the extended, ionized-gas emission of 24 early-type galaxies (ETGs) at $0 < z < 1$ from the ESO Distant Cluster Survey (EDisCS). We discuss different possible sources of ionization and favour star-formation as the main cause of the observed emission. Ten galaxies have disturbed gas kinematics, while 14 have rotating gas disks. In addition, 15 galaxies are in the field, while 9 are in the infall regions of clusters. This implies that, if the gas has an internal origin, this is likely stripped as the galaxies get closer to the cluster centre. If the gas instead comes from an external source, then our results suggest that this is more likely acquired outside the cluster environment, where galaxy-galaxy interactions more commonly take place. We analyse the Tully-Fisher relation of the ETGs with gas disks, and compare them to EDisCS spirals. Taking a matched range of redshifts, $M_B < -20$, and excluding galaxies with large velocity uncertainties, we find that, at fixed rotational velocity, ETGs are 1.7 mag fainter in M_B than spirals. At fixed stellar mass, we also find that ETGs have systematically lower specific star-formation rates than spirals. This study constitutes an important step forward towards the understanding of the evolution of the complex ISM in ETGs by significantly extending the look-back-time baseline explored so far.

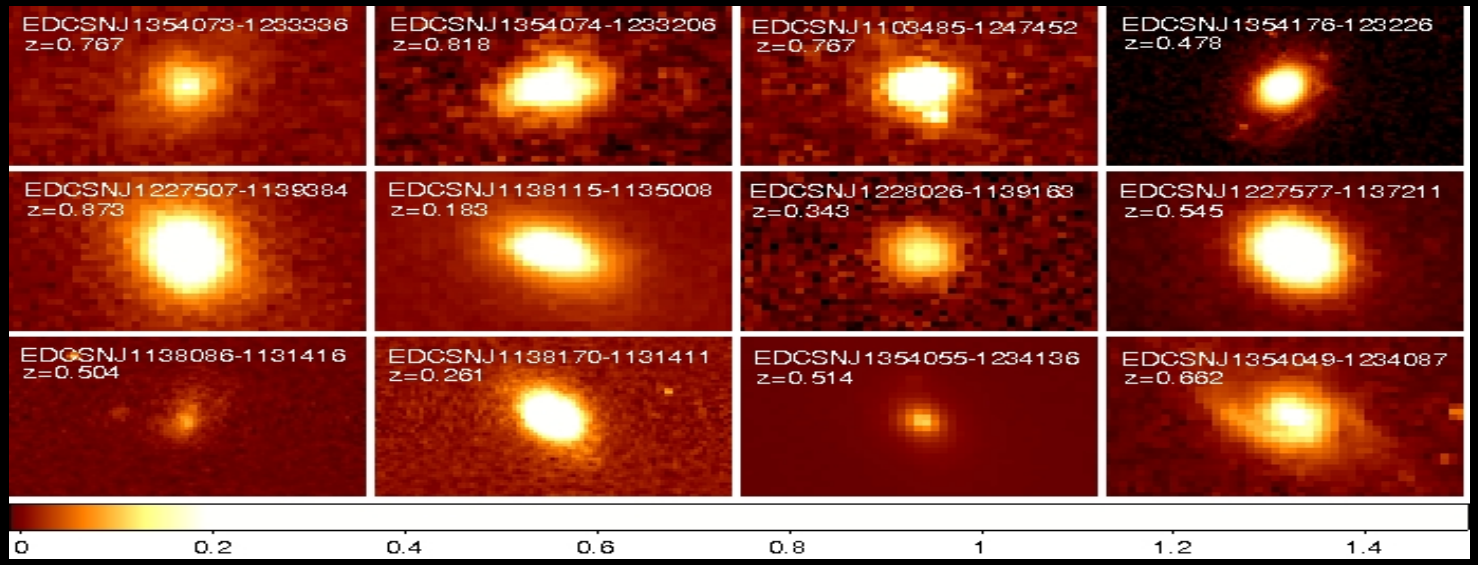
Key words: galaxies: elliptical and lenticular, cD -galaxies: evolution -galaxies: formation -galaxies: kinematics and dynamics -galaxies: ISM

Ionized gas disks in ETGs at 0<z<1

Jaffé et al. 2014 (MNRAS, accepted)

→ ETGs have long been regarded as a homogeneous population of passively-evolving galaxies (colour, fundamental plane, line strengths)
→ Owing to an increase in instrumental sensitivity in the last decades, a number of observations have gradually revealed the presence of a complex ISM in nearby ETGs (X-rays, HI, warm ionized gas, dust)
→ The new "slow and fast rotator" scheme of SAURON/ATLAS^{3D}

➔ **We found 24 ETGs with extended emission at 0<z<1, significantly extending the look-back-time baseline explored so far**



They represent >12% of the emission-line galaxy population at z<1

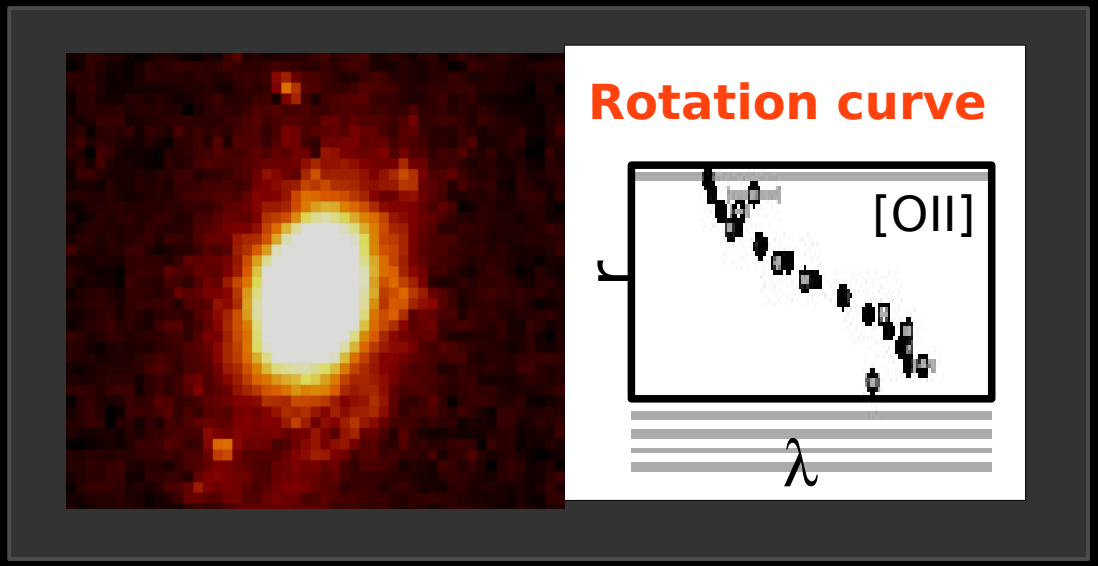
...

Ionized gas disks in ETGs at 0<z<1

Jaffé et al. 2014 (MNRAS, accepted)

→ **Kinematics (gas):**

- 14 had regular disk kinematics
- and 10 showed signs of disturbed gas kinematics



Ionized gas disks in ETGs at 0<z<1

Jaffé et al. 2014 (MNRAS, accepted)

→ Source of ionization

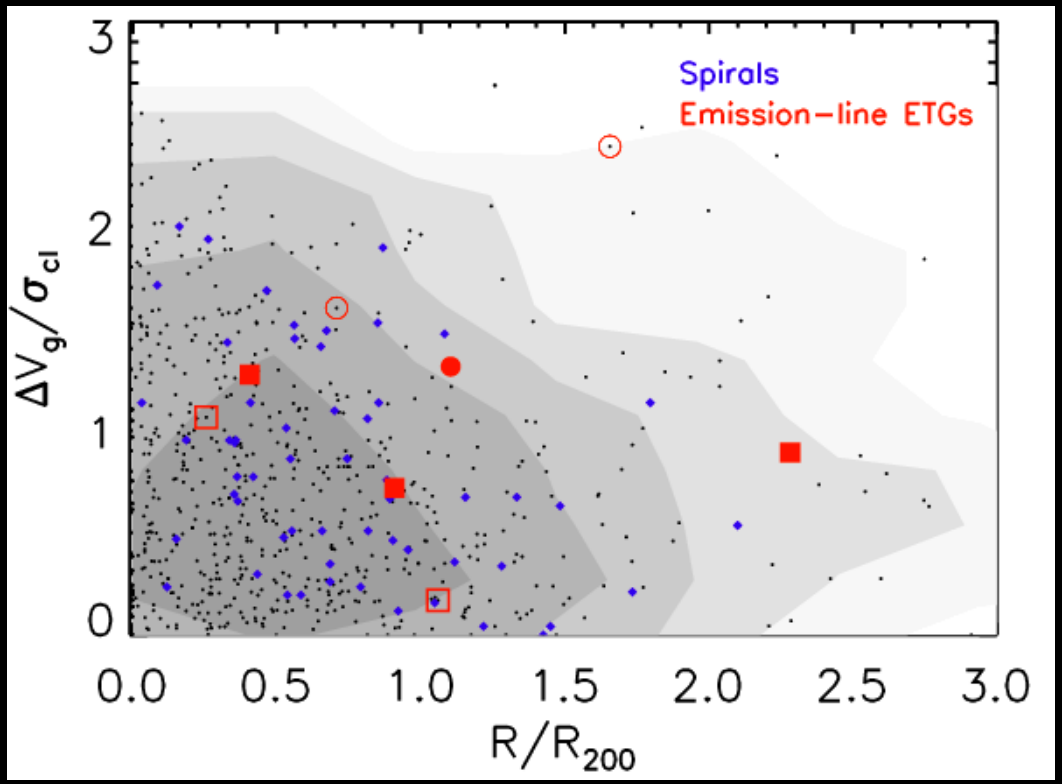
From indicators such as:

- EW(Hδ+Hγ) vs. D4000
- [OII]/Hb ratios (always < 6.7)
- extent of emission
- colours (most in red sequence but many are bluer)

We conclude that ionization is most likely caused by **star formation**, and not AGN activity or post-AGB stars.

→ Environment

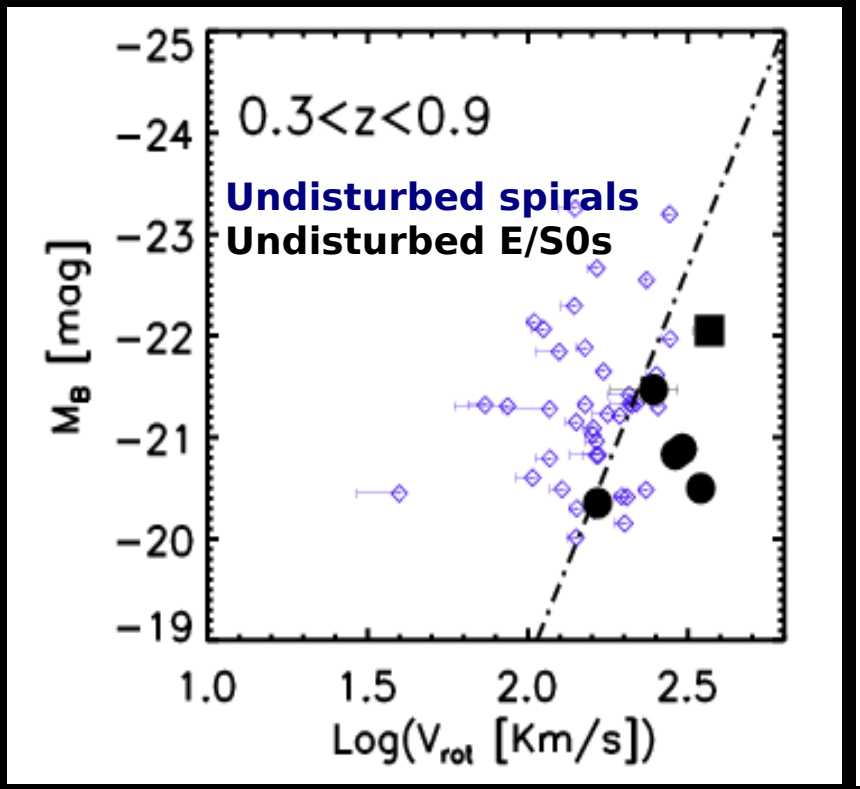
Most ETGs are in the **field**, and the ones found in clusters are located in the **outskirts**



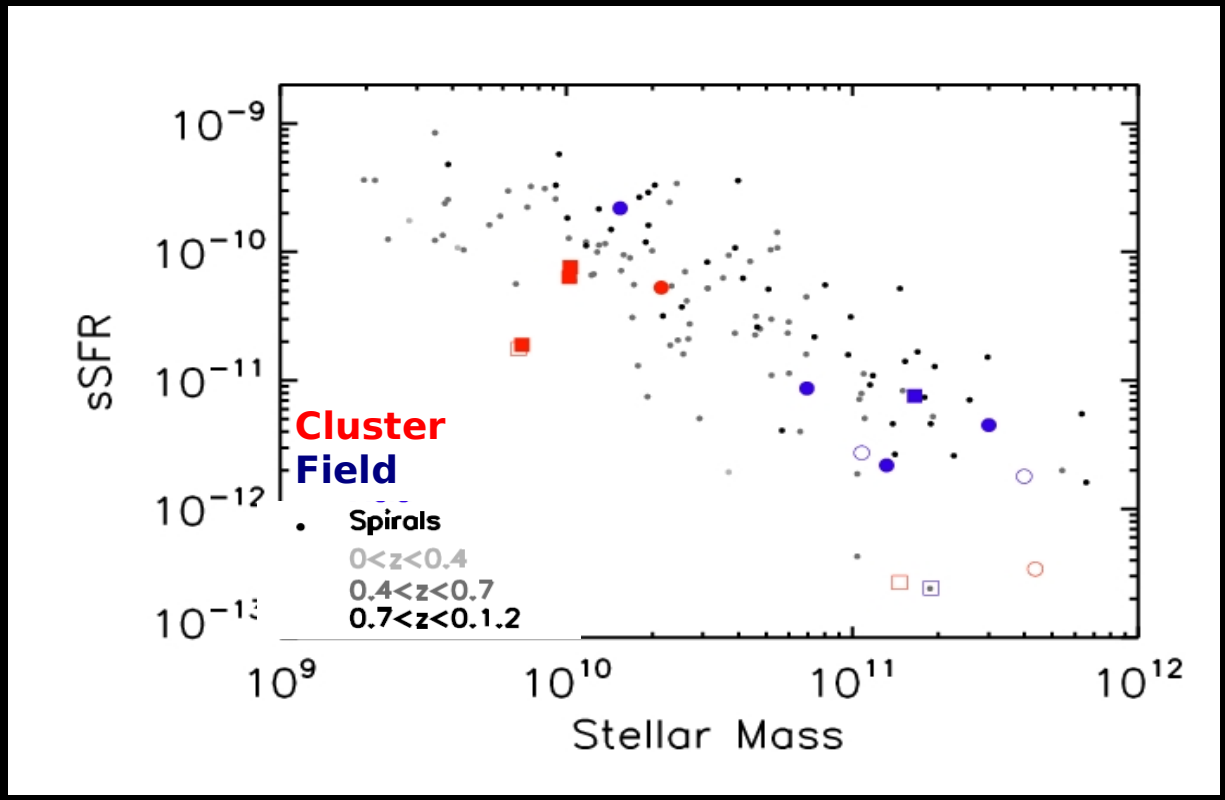
Ionized gas disks in ETGs at 0<z<1

Jaffé et al. 2014 (MNRAS, accepted)

→ The Tully Fisher relation
E/S0s are 1.7 mag fainter than the spirals at fixed Vrot



→ The sSFR vs stellar mass relation
Cluster ETGs have systematically lower sSFR, and field ETGs have the lowest sSFR and the highest stellar masses



Disturbed kinematics
Undisturbed (disk) kinematics
Ellipticals
S0s

The cupcake model:

An underlying old stellar population with a “frosting” of star formation

But where did the gas come from?

External origin:

Disturbed gas kinematics
Kinematic misalignments between gas & stars

Internal production:

Mass is returned into the ISM from evolved stars

See Jaffé *et al.* (2014)