Two-Face(s): ionized and neutral gas winds in the local Universe.

A. Concas[1], P. Popesso[1], M. Brusa[2,3], V. Mainieri[4], and D. Thomas[5]

[1] Excellence Cluster Universe, Boltzmannstr. 2 D-85748 Garching, Germany
[2] Dipartimento di Fisica e Astronomia, Universitá degli Studi di Bologna, Via Piero Gobetti 93/2, 40139 Bologna, Italy
[3] INAF−Osservatorio Astronomico di Bologna, Via Piero Gobetti, 93/3, 40139 Bologna, Italy
[4] European Southern Observatory, Karl-Schwarzschild-str. 2, 85748 Garching, Germany
[5] Institute of Cosmology and Gravitation, University of Portsmouth, Dennis Sciama Building, Burnaby Road, Portsmouth, PO1 3FX, UK

Received; accepted

ABSTRACT

We present a comprehensive study of the interstellar NaI λ5890, 5895 (NaD) resonant lines in a complete spectroscopic sample of $\sim 600,000$ galaxies drawn from Sloan Digital Sky Survey (SDSS, DR7) in order to look for cold-gas outflows in the local Universe. This is the first time that doppler blue-shifts of the NaD absorption feature have been investigated as a tracer of cold gas kinematics (T < 1000 K) with a statistically significant sample that includes passive, star-forming and starburst galaxies. Individual galaxy spectra are stacked in bins of stellar mass ($M_\star$) and star formation rate (SFR) and the dependence of galactic winds, with respect to the galaxies position in the SFR-$M_\star$ plane is investigated. While in most cases the interstellar medium (ISM) absorption and emission lines are fixed at the galaxy systemic velocity, at the higher SFR tail (SFR> $12.5 M_\odot yr^{-1}$), we find evidence of blue-shifted NaD absorption profiles (by more than instrumental resolution, 70 km/s), which we interpret as evidence of neutral outflowing gas. We explore the properties of the ISM in these galaxies with high SFR, in particular relating the absorption NaD line shape with the galaxy geometry in galaxies with different ionisation mechanisms: Active Galactic Nuclei (AGN) and star-formation. We find that: a) the ISM NaD absorption lines show a clear transition from a strong disk-like component, perfectly centered to the systemic velocity, in the edge-on system (inclination $i > 50°$ of the disk rotation axis), to an outflow, blue-shifted, component in face-on galaxies ($i < 50°$); b) these trends are observed in galaxies classified as "purely" star-forming and AGN dominated objects. In addition to this, we compare the kinematics of the neutral gas with the kinematics of the ionized gas as traced by the [OIII]λ5007 emission lines. We find that, in these high SFR galaxies, the perturbations of the [OIII] emission line are present only in AGN or composite AGN/star-forming systems, consistent with Concas et al. (2017). In our AGN sample, the presence of the oxygen line perturbation is independent to the stellar disk inclination: in both the face-on and edge-on systems, the velocity associated with the broad and blue-shifted gaussian component is $\sim 125 \pm 45$ km/s, velocity dispersion of $\sim 460 \pm 30$ km/s and a mean maximum velocity of $\sim -1042 \pm 106$ km/s. In

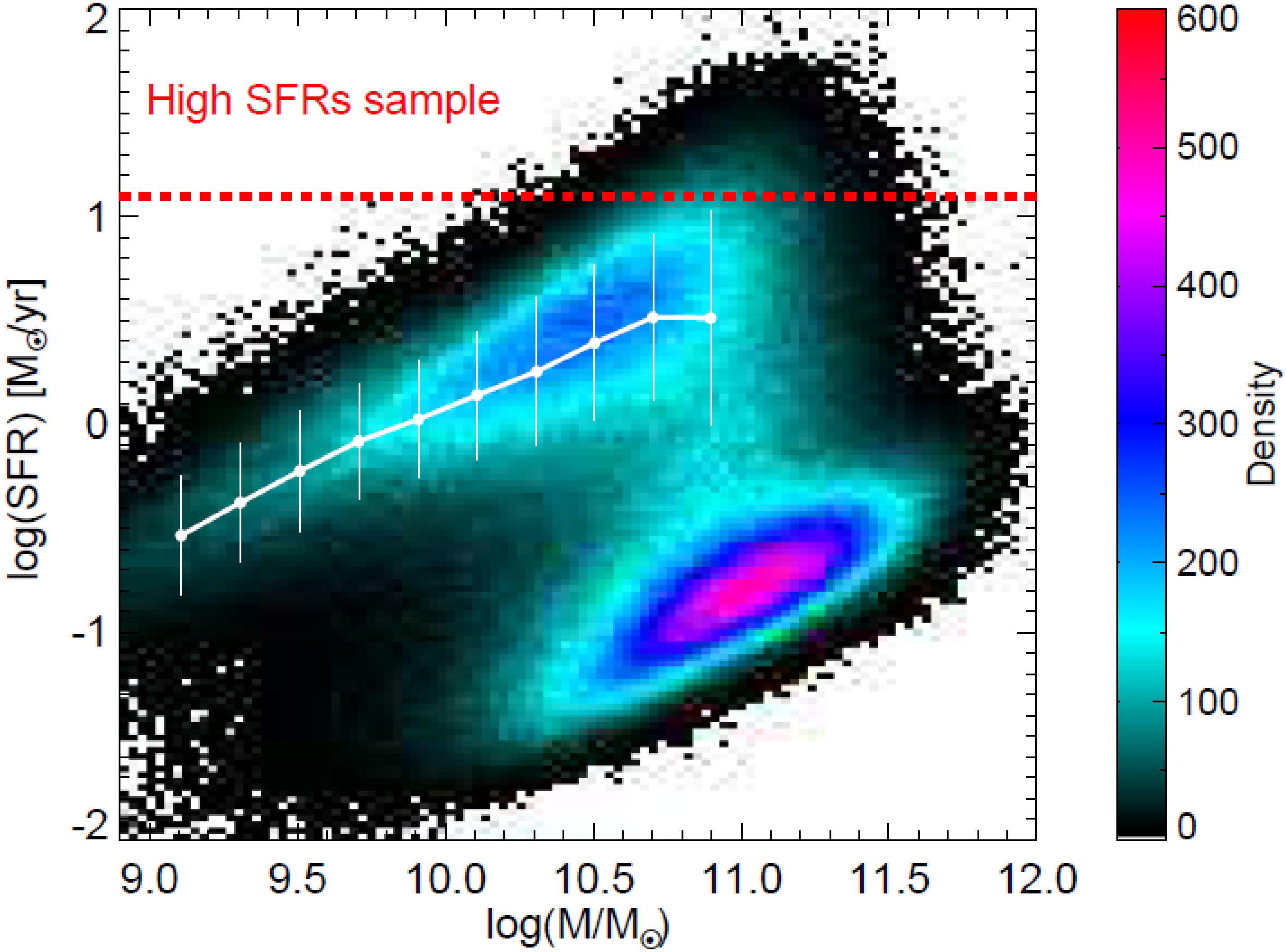


Fig. 1. SFR-$M_\star$ plane for DR7 SDSS galaxies. The dashed red line divides the galaxies with high SFRs that shows blue-shifted Na D lines from the rest of the sample below. The white line shows the position of the so-called "Main-Sequence" (MS) of star−forming galaxies. The MS is computed as the mode and the dispersion of the SFR distribution in stellar mass bins following the example of (Renzini & Peng 2015) .

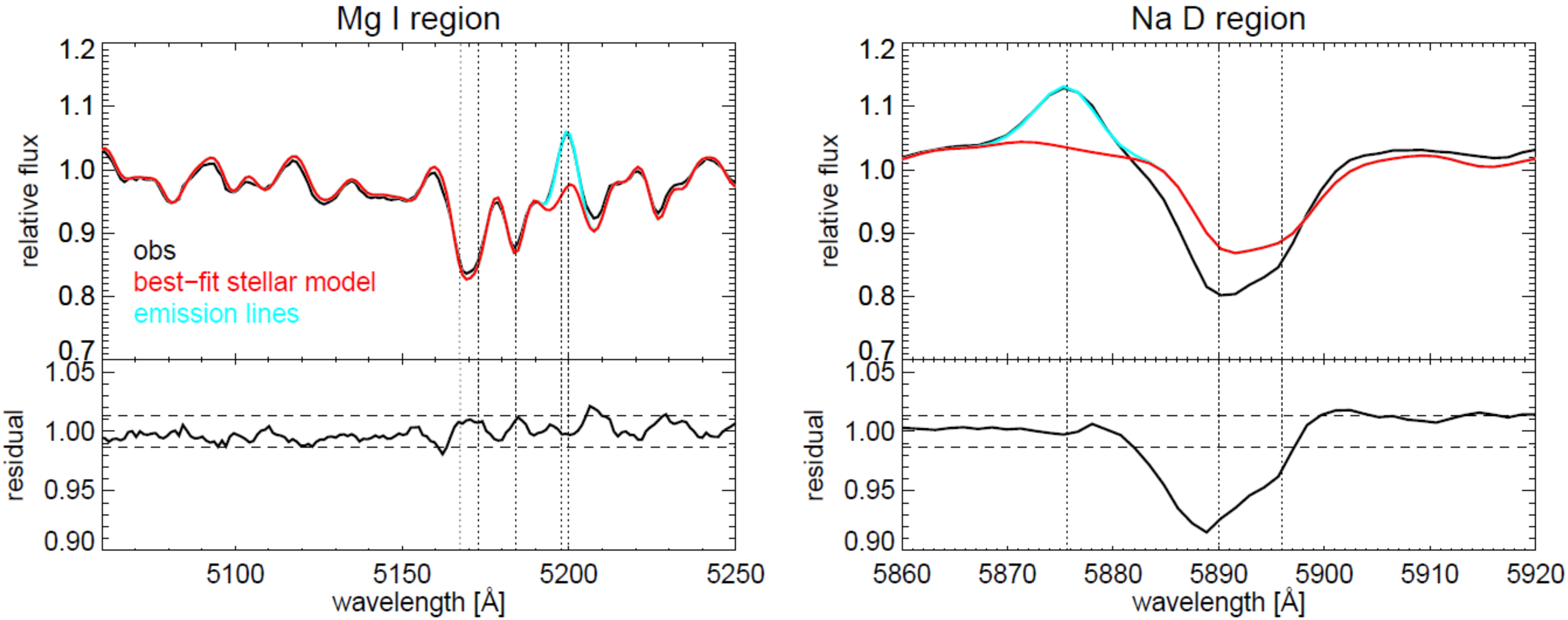


Fig. 3. Example of our continuum fit and subtraction performed for the stacked spectrum whit log(SFR)= $1.4 M_{\odot} yr^{-1}$ and log($M_{\star}$)= $10.9 M_{\odot}$ in the Mg I and Na D regions, left and right panel respectively. The observed stacked spectrum is shown with a solid black line, the best-fit stellar continuum model in red and the emission lines in cyan. The dotted lines indicate the stellar Mg I triplet at $\lambda\lambda$5167, 5173, 5184 Å the [NI]λ5198, 5200 Å emission lines, the He I λ5876 emission and the Na I doublet $\lambda\lambda$5890, 5896. The bottom panels shows the residual spectra (solid black line) and the level of fluctuations in the fit residuals (dashed line). The Mg I region is well reproduced by the stellar fit with residuals lower than the mean scatter. The Na D fit is affected by residuals from a blue-shifted extra absorption Na D component.

provided in the MPA-JHU catalog[2], which furnish a measure of

the SFR-M$\star$ plane with the caveat that the central region, at

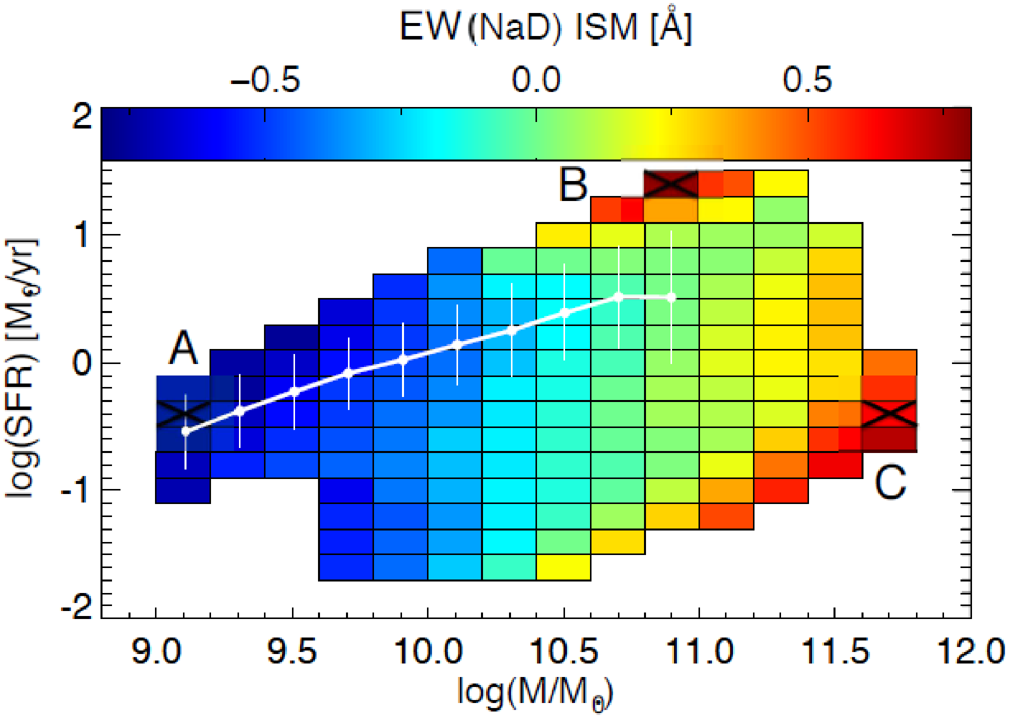
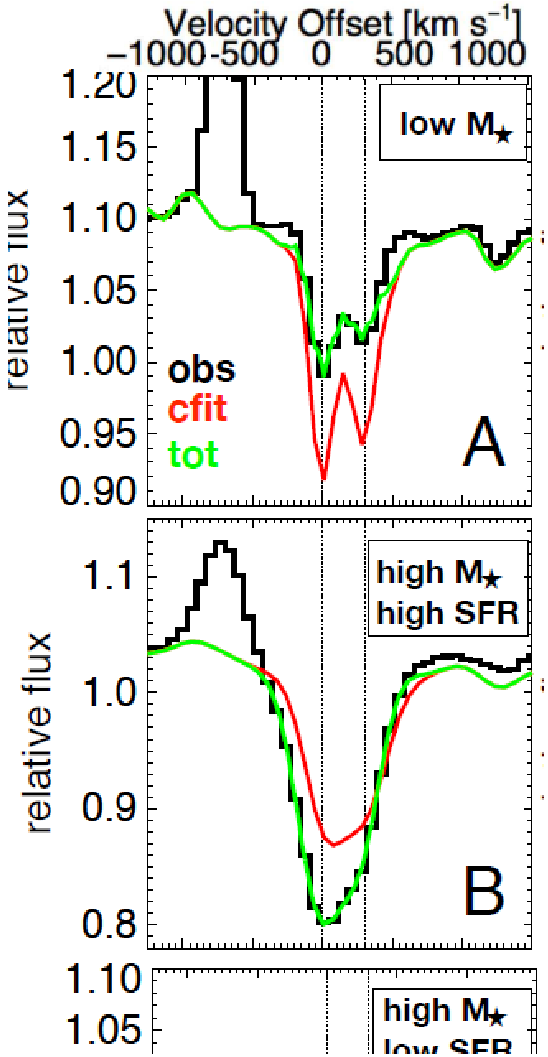
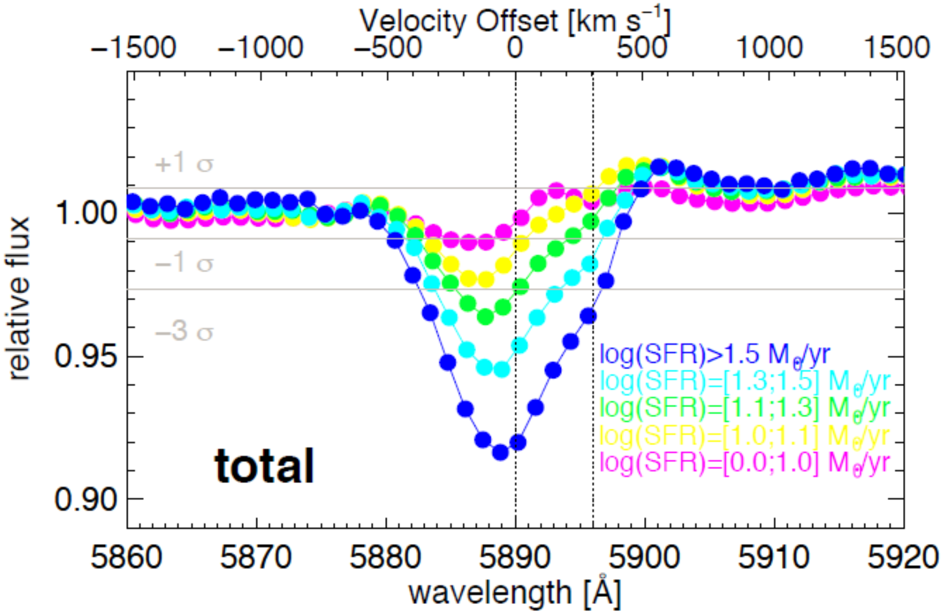


Fig. 4. EW of the ISM NaD line in the SFR-M$_\star$ diagram for the C17 Sample. Negative EW values correspond to a residual emission and positive values to an absorption. The white line shows the mode and dispersion of the MS. As a example, we show the NaD line fit in Fig. 5 for the crossed Bins, A, B and C.





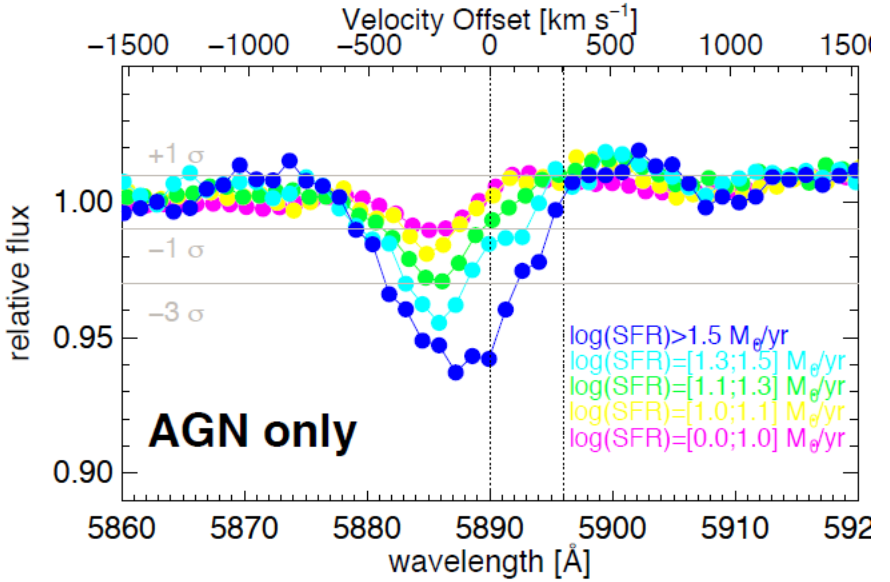


Fig. 6. Variation of the ISM Na D resonant line profile as a function
the SFR for the galaxies with log(M)$_\star$ $>$ 10.7 M$_\odot$ and log(SFR)$>$ 0
M$_\odot$/yr in the total sample (top panel) and in the AGN dominated objec
(bottom panel). The intensity of the line increases with the increase
the SFR, from the magenta to the blue curves. Only the galaxies wi
SFR$\geq$ 12 M$_\odot$/yr show a blue-shifted NaD line, detected with good lev
of significance $> 3\sigma$ (or $\sim$ 3 for the noisier AGN spectra). The AG
subsample shows the same trend observed in the total sample.

Связь с наклоном диска

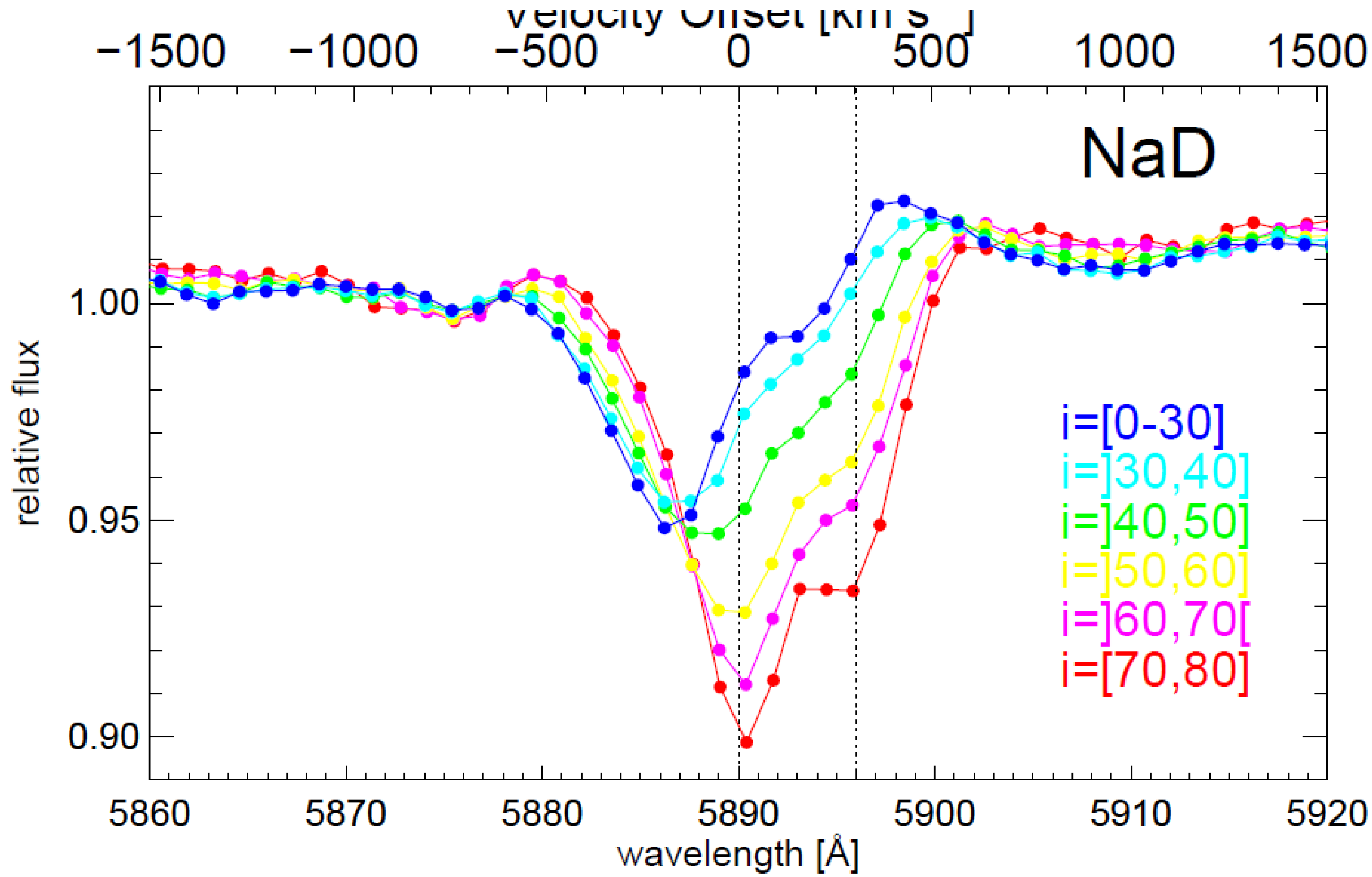
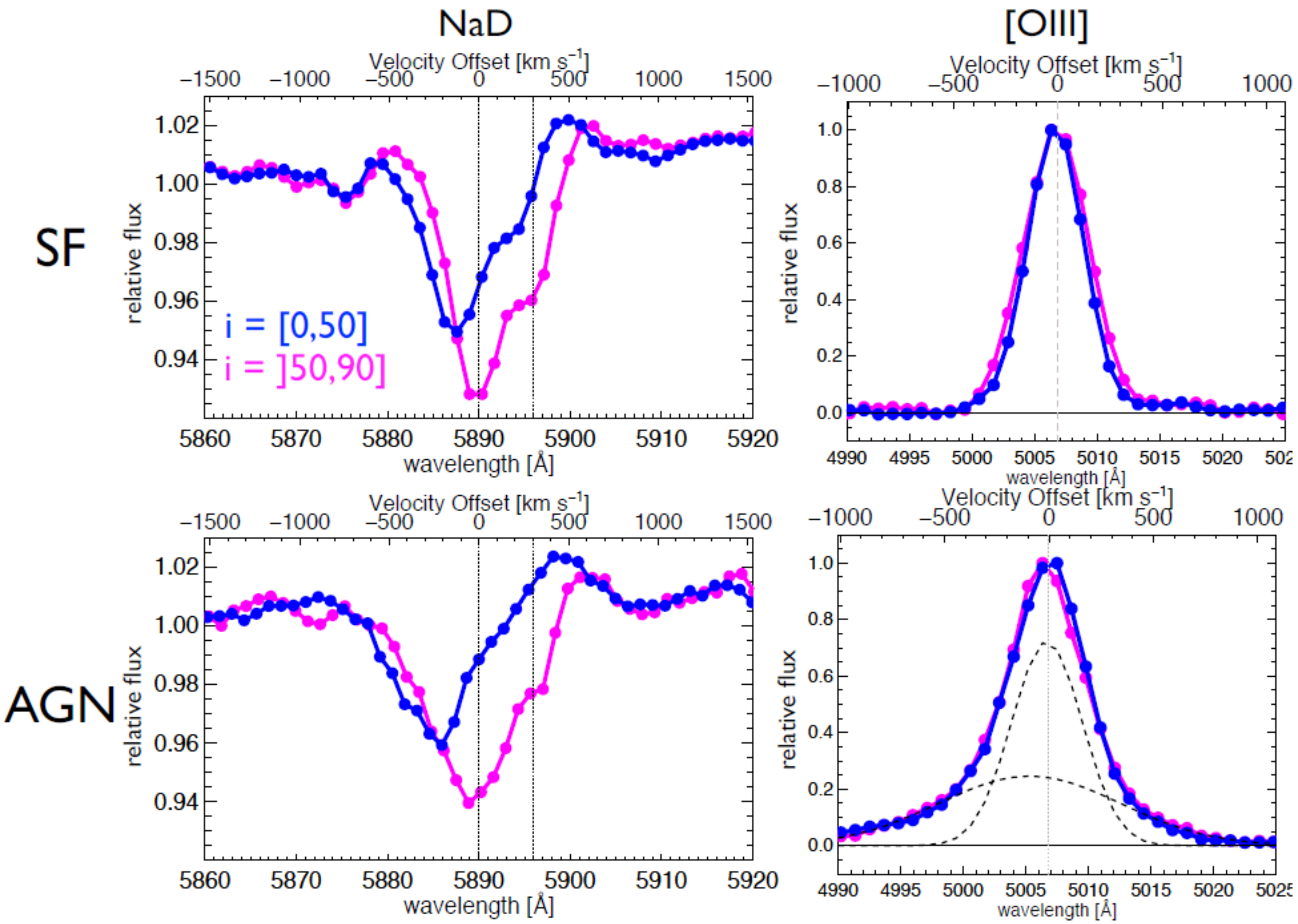


Fig. 7. Variation of the ISM Na D resonant line profile as a function of the galaxy inclination for the galaxies with SFR$\geq 10^{1.1}$ $M_\odot/yr$ including "Pure" SF galaxies and galaxies with an AGN contribution. The line is centred to the systemic velocity in the edge-on sample and it shows a progressive blue-shift according with the decrease of the mean disk inclination. The maximum shift is reached by the more face-on galaxies (blue curve).



ig. 10. Correlation between the Na I D resonant line, [OIII]λ5007 emission-line profiles (left and right panels respectively) and the galaxy stell
isk inclination (face-on and edge-on systems with inclination respectively i = [0, 50] and i =]50, 90]). The spectra are extracted from the "pur
F galaxies (top panels) and for the AGN subsample (right panels). The Na D line shift clearly correlate with the galaxy inclination in both the S
nd AGN dominated samples. The [OIII] emission line are independent to the galaxy morphology but shown a strong shape variation between th
F and AGN subsamples. In the oxygen AGN panel, the black dashed lines illustrate the two-Gaussian components, narrow and broad blue-shift
omponent, needed to best fit the data.

Основные выводы

- Массивные галактики демонстрируют

Wind NaD в поглощении, маломассивные – в эмиссии.

Для SFR >12.5 Mc/yr – линии blueshifted/

Особенно для face-on (до 460 км/с).

OIII shift не коррелирует с наклоном.

The MUSE Hubble Ultra Deep Field Survey: V . Spatially resolved stellar kinematics of galaxies at redshift $0.2 \lesssim z \lesssim 0.8$ *

Adrien Guérou[1, 2, 3], Davor Krajnović[4, **], Benoit Epinat[1, 2, 5], Thierry Contini[1, 2], Eric Emsellem[3, 6], Nicolas Bouché[1, 2],
Roland Bacon[6], Leo Michel-Dansac[6], Johan Richard[6], Peter M. Weilbacher[4], Joop Schaye[7], Raffaella Anna Marino[8],
Mark den Brok[8], and Santiago Erroz-Ferrer[8]

1. IRAP, Institut de Recherche en Astrophysique et Planétologie, CNRS, 14, avenue Edouard Belin, F-31400 Toulouse, France
2. Université de Toulouse, UPS-OMP, Toulouse, France
3. European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany
4. Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, D-14482 Potsdam, Germany
5. Aix Marseille Université, CNRS, LAM, Laboratoire d'Astrophysique de Marseille, UMR 7326, 13388 Marseille, France
6. Univ Lyon, Univ Lyon1, ENS de Lyon, CNRS, Centre de Recherche Astrophysique de Lyon UMR5574, F-69230, Saint-Genis-Laval, France
7. Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA Leiden, The Netherlands
8. ETH Zurich, Institute of Astronomy, Wolfgang-Pauli-Str. 27, CH-8093 Zurich, Switzerland

Received 31 March 2017 ; accepted 26 June 2017

We present spatially resolved stellar kinematic maps, for the first time, for a sample of 17 intermediate redshift galaxies ($0.2 \lesssim z \lesssim 0.8$). We used deep MUSE/VLT integral field spectroscopic observations in the Hubble Deep Field South (HDFS) and Hubble Ultra Deep Field (HUDF), resulting from ≈ 30 h integration time per field, each covering $1' \times 1'$ field of view, with $\approx 0''.65$ spatial resolution. We selected all galaxies brighter than 25 mag in the I band and for which the stellar continuum is detected over an area that is at least two times larger than the spatial resolution. The resulting sample contains mostly late-type disk, main-sequence star-forming galaxies with $10^{8.5}\,\mathrm{M}_{\odot} \lesssim \mathrm{M}_{*} \lesssim 10^{10.5}\,\mathrm{M}_{\odot}$. Using a full-spectrum fitting technique, we derive two-dimensional maps of the stellar and gas kinematics, including the radial velocity V and velocity dispersion σ. We find that most galaxies in the sample are consistent with having rotating stellar disks with roughly constant velocity dispersions and that the second order velocity moments $V_{\mathrm{rms}} = \sqrt{V^2 + \sigma^2}$ of the gas and stars, a scaling proxy for the galaxy gravitational potential, compare well to each other. These spatially resolved observations of the stellar kinematics of intermediate redshift galaxies suggest that the *regular* stellar kinematics of disk galaxies that is observed in the local Universe was already in place 4 – 7 Gyr ago and that their gas kinematics traces the gravitational potential of the galaxy, thus is not dominated by shocks and turbulent motions. Finally, we build dynamical axisymmetric Jeans models constrained by the derived stellar kinematics for two specific galaxies and derive their dynamical masses. These are in good agreement (within 25 %) with those derived from simple exponential disk models based on the gas kinematics. The obtained mass-to-light ratios hint towards dark matter dominated systems within a few effective radii.

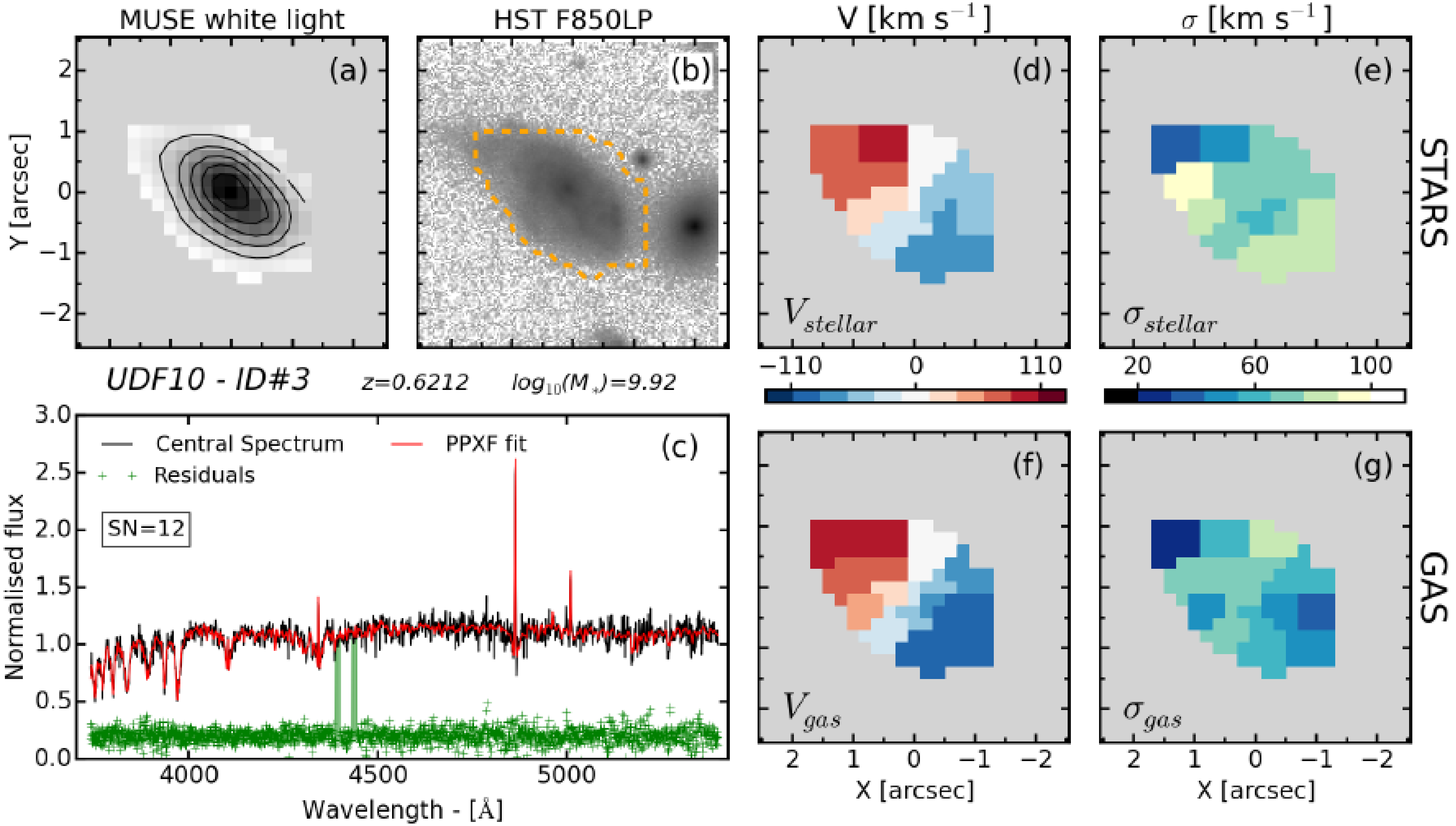
Key words. Galaxies: formation - Galaxies: evolution - Galaxies: Kinematics and dynamics - Galaxies: Stellar content

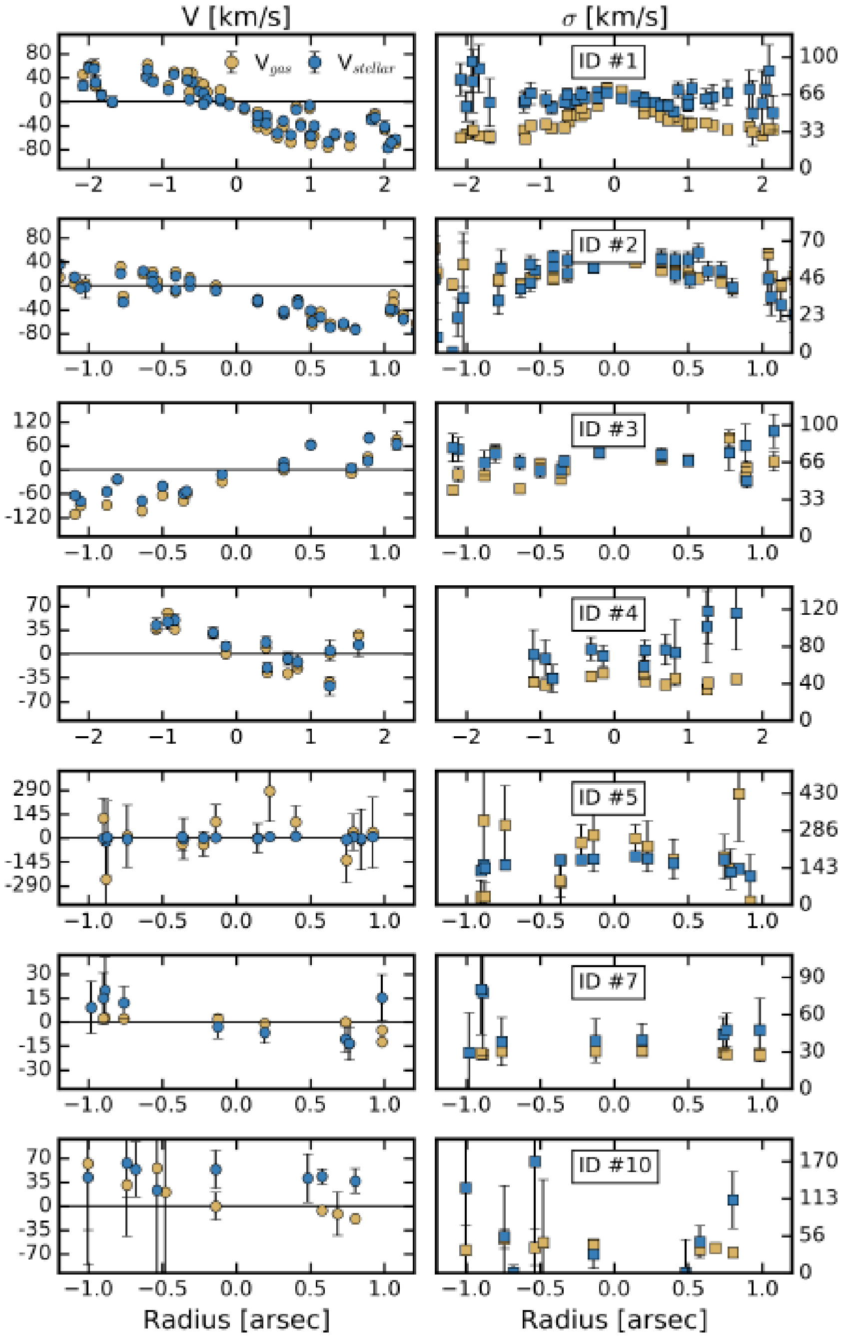
1. Introduction

The kinematics of galaxies is of paramount importance for our

ers (Arnold et al. 2014; Naab et al. 2014; Haines et al. 2015) and gas accretion (Davis et al. 2011a; Cheung et al. 2016) in

Fig. A.11. UDF10-ID #2 - caption as Fig. 7




V [km/s]
σ [km/s]
V$_{gas}$
V$_{stellar}$
ID #1
ID #2
ID #3
ID #4
ID #5
ID #7
ID #10
Radius [arsec]
Radius [arsec]