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Robust H I kinematics of gas-rich ultra-diffuse galaxies: hints of a weak-feedback formation scenario

Pavel E. Mancera Piña^{1,2*}, Filippo Fraternali¹, Kyle A. Oman^{1,3}, Elizabeth A. K. Adams^{2,1}, Cecilia Bacchini^{1,4,5}, Antonino Marasco⁶, Tom Oosterloo^{2,1}, Gabriele Pezzulli⁷, Lorenzo Posti⁸, Lukas Leisman⁹, John M. Cannon¹⁰, Enrico M. di Teodoro¹¹, Lexi Gault⁹, Martha P. Haynes¹², Kameron Reiter⁹, Katherine L. Rhode¹³, John J. Salzer¹³ and Nicholas J. Smith¹³

¹ Kapteyn Astronomical Institute, University of Groningen, Landleven 12, 9747 AD, Groningen, The Netherlands

² ASTRON, Netherlands Institute for Radio Astronomy, Postbus 2, 7900 AA Dwingeloo, The Netherlands

³ Institute for Computational Cosmology, Department of Physics, Durham University, Science Laboratories, South Road, Durham DH1 3LE, UK

⁴ Dipartimento di Fisica e Astronomia, Università di Bologna, via Gobetti 93/2, I-40129, Bologna, Italy

⁵ INAF-Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, via Gobetti 93/3, I-40129 Bologna, Italy

⁶ INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50157, Firenze, Italy

⁷ Department of Physics, ETH Zurich, Wolfgang-Pauli-Strasse 27, CH-8093 Zurich, Switzerland

⁸ Université de Strasbourg, CNRS UMR 7550, Observatoire astronomique de Strasbourg, 11 rue de l'Université, 67000 Strasbourg, France

⁹ Department of Physics and Astronomy, Valparaiso University, Neils Science Center, 1610 Campus Drive East, Valparaiso, IN 46383, USA

¹⁰ Department of Physics & Astronomy, Macalester College, 1600 Grand Avenue, Saint Paul, MN 55105, USA

¹¹ Department of Physics & Astronomy, Johns Hopkins University, Baltimore, MD 21218, USA

¹² Cornell Center for Astrophysics and Planetary Science, Space Sciences Building, Cornell University, Ithaca, NY 14853, USA

¹³ Department of Astronomy, Indiana University, 727 East Third Street, Bloomington, IN 47405, USA

Выборка: Gas-rich (ALFALFA) UDG

Table 1. Properties of our galaxy sample.

ID AGC (1)	RA (J2000) [hh:mm:ss.ss] (2)	DEC (J2000) [dd:mm:ss.ss] (3)	V_{sys} [km s ⁻¹] (4)	D [Mpc] (5)	R_d [kpc] (6)	$\log(M_{\star}/M_{\odot})$ (7)	$\log(M_{\text{HI}}/M_{\odot})$ (8)	Inc. [deg] (9)	PA [deg] (10)	V_{circ} [km s ⁻¹] (11)	$\langle\sigma\rangle$ [km s ⁻¹] (12)
114905	01:25:18.60	+07:21:41.11	5435	76	1.79 ± 0.04	8.30 ± 0.17	9.03 ± 0.08	33	85	19^{+6}_{-4}	$\lesssim 4$
122966	02:09:29.49	+31:51:12.77	6509	90	4.15 ± 0.19	7.73 ± 0.12	9.07 ± 0.05	34	300	37^{+6}_{-5}	7
219533	11:39:57.16	+16:43:14.00	6384	96	2.35 ± 0.20	8.04 ± 0.12	9.21 ± 0.18	42	115	37^{+5}_{-6}	$\lesssim 4$
248945	14:46:59.50	+13:10:12.20	5703	84	2.08 ± 0.07	8.52 ± 0.17	8.78 ± 0.08	66	300	27^{+3}_{-3}	$\lesssim 4$
334315	23:20:11.73	+22:24:08.03	5107	73	3.76 ± 0.14	7.93 ± 0.12	9.10 ± 0.10	45	185	25^{+5}_{-5}	7
749290	09:16:00.95	+26:38:56.93	6516	97	2.38 ± 0.14	8.32 ± 0.13	8.98 ± 0.08	39	130	26^{+6}_{-6}	$\lesssim 4$

(1) Arecibo General Catalogue ID. (2-3) Right ascension and declination. (4) Systemic velocity. (5) Distance, taken from L17, has an uncertainty of ± 5 Mpc. (6) Optical disc scale length, obtained from an exponential fit to the r -band surface brightness profile. (7) Stellar mass. (8) H I mass. (9) Inclination, derived from the H I data with an uncertainty of $\pm 5^\circ$. (10) Position angle, derived from the H I data, with an uncertainty of $\pm 8^\circ$. (11) Circular speed. (12) Mean value of the gas velocity dispersion. (13) Radius of the outermost ring of the rotation curve.

Фотометрия:

- WYIN 3.5 m, фильтр r
- Апертурные оценки
- Профиль яркости → вписывается гауссиана

VLA: 21cm, разрешение $\sim 15''$

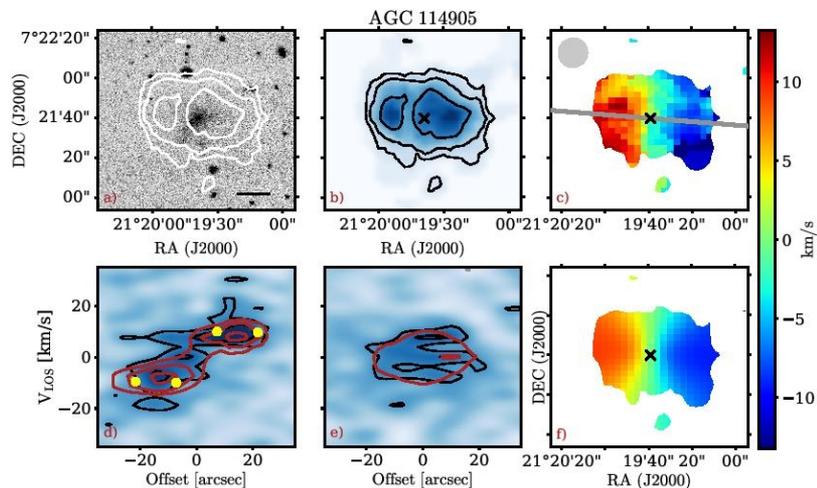


Figure 1. Data and kinematic models for the gas-rich UDG AGC 114905. *a*): r -band image with H I contours on top at 1, 2, 4×10^{20} atoms cm^{-2} , with the lowest one at $S/N \approx 3$. The black solid line indicates a physical scale of 5 kpc. *b*): total H I map in blue, and contours as in panel *a*. *c*): Observed velocity field (first-moment map). The grey line shows the major axis, while the grey ellipse shows the beam. *d*): PV diagram along the major axis. Black and red contours correspond to data and best-fit model, respectively, and are at the 2 σ and 4 σ levels. If present, grey dashed contours indicate negative values in the data. The recovered rotation velocities are indicated with the yellow points. *e*): PV diagram along the minor axis (perpendicular to the major axis), colours as in *d*). *f*): Modelled velocity field. The black cross in panel *b*, *c* and *f* shows the kinematic centre. The rightmost panel shows the velocity co-

WSRT

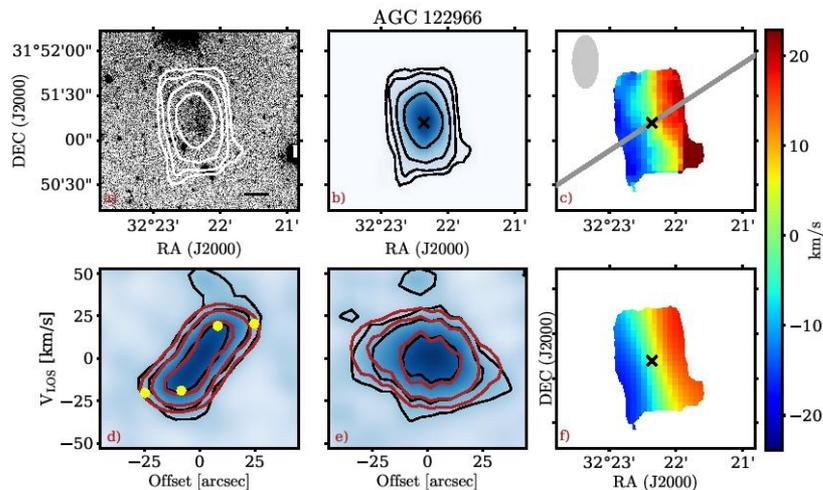
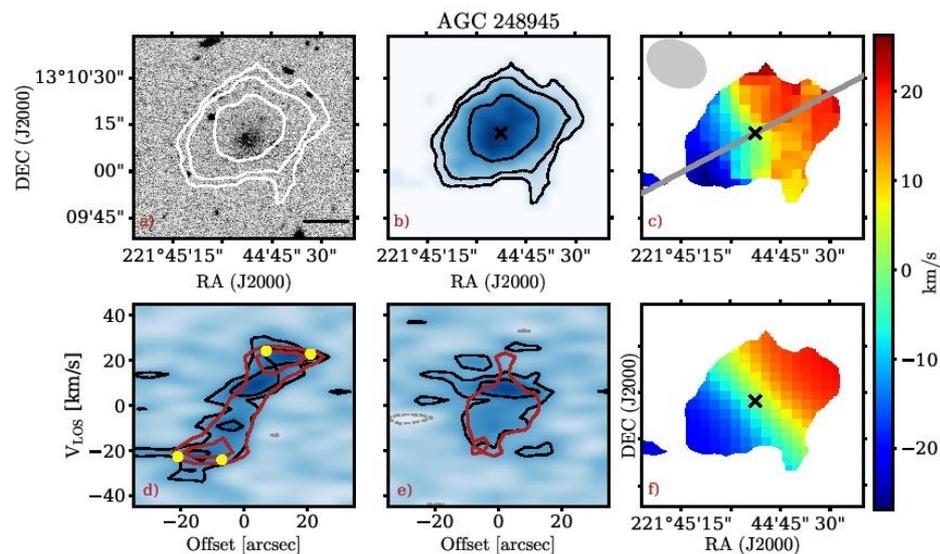
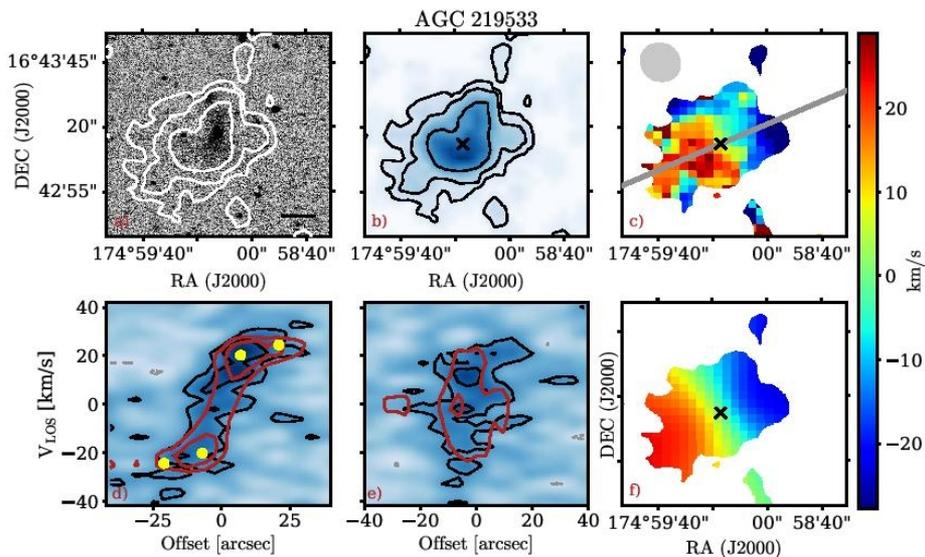
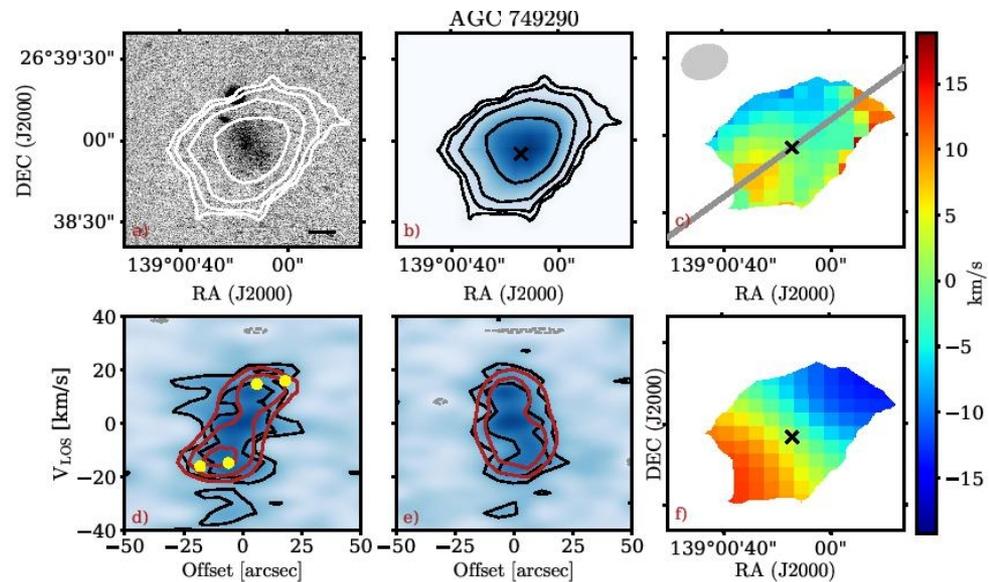
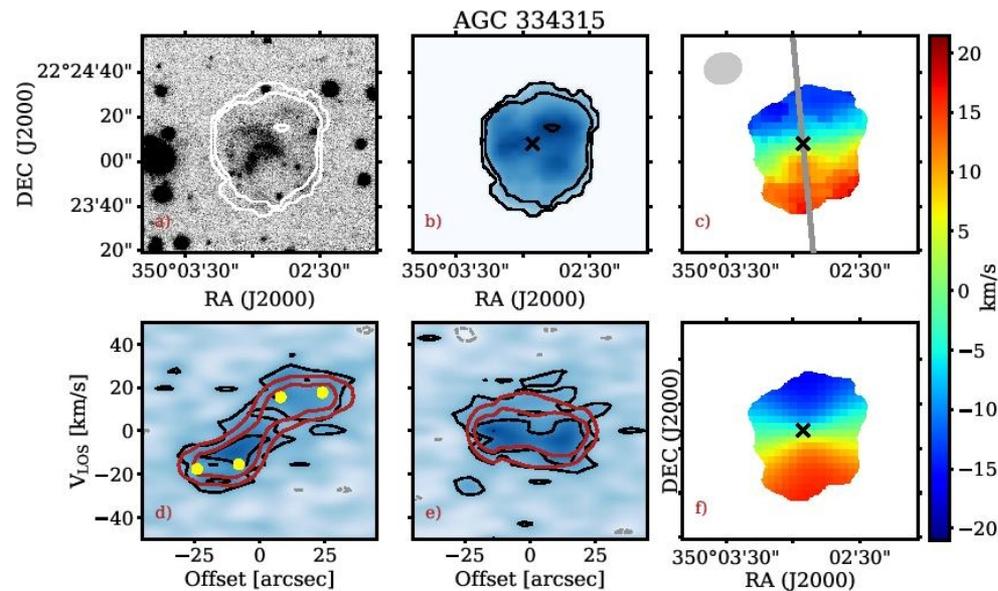


Figure 2. Data and kinematic models for the gas-rich UDG AGC 122966. Panels and symbols as in Figure 1. The H I contours are at 0.35, 0.7, 1.4 and 2.8×10^{20} atoms cm^{-2} . Note that the kinematic and morphological position angles seem to be different, but this apparent effect is due to the peculiar elongated shape of the WSRT beam (see Appendix A)

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Карлики с холодными газовыми дисками!

... ТОНКИМИ!

UDGs. The scale height of such discs is given by the equation

$$h = \frac{\sigma^2}{\pi G \Sigma_{\text{gas}}}, \quad (4)$$

with σ the gas velocity dispersion, G the gravitational constant and Σ_{gas} the gas surface density.

Assuming a mean velocity dispersion constant with radius and the mean surface density of the disc⁶, we obtain a mean (median) disc scale height of $\langle h \rangle = 260$ (150) pc. Note that these values may in reality be smaller, as *i*) we

...baryon-dominated!

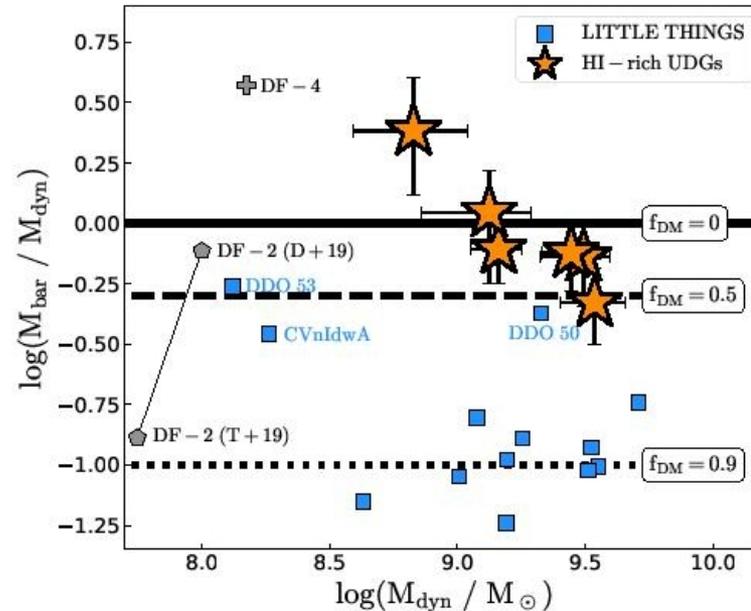
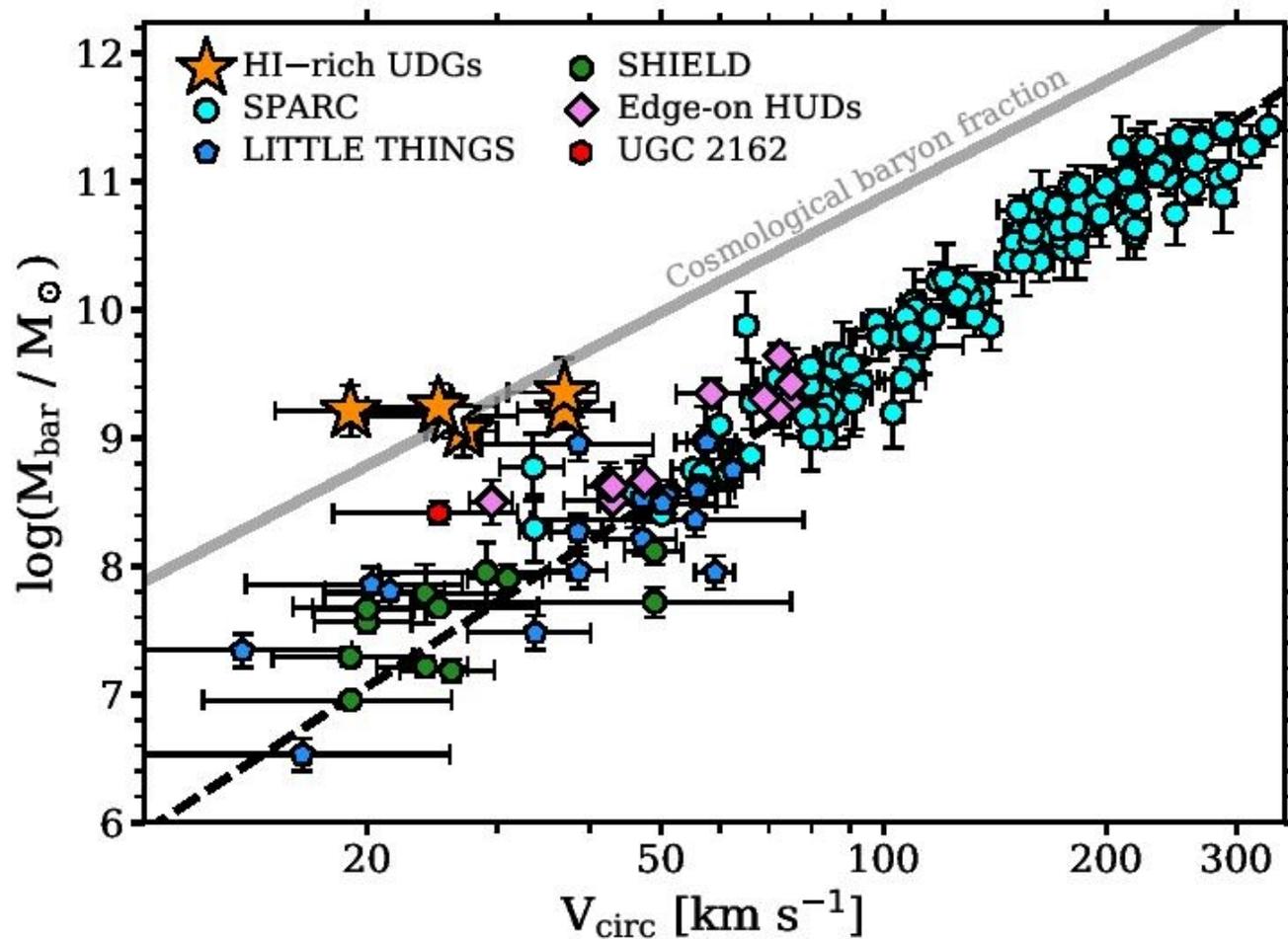


Figure 4. Baryonic to dynamical mass ratio as a function of the dynamical mass, measured inside $\approx 4 R_d$. The solid, dashed and dotted lines show the position where galaxies with 0%, 50% and 90% dark matter lie, respectively. LITTLE THINGS galaxies (Iorio et al. 2017) are shown for comparison, as well as two estimates for DF-2 (Danieli et al. 2019, D+19 and Trujillo et al. 2019, T+19) and DF-4 van Dokkum et al. (2019), for which we assume $M_{\text{bar}} = M_{\star}$.

И, соотвественно, отскок на BTFR...



...СВЯЗАН С ПОВЫШЕННЫМ ЗВЕЗДНЫМ МОМЕНТОМ И БОЛЬШИМ ДИСКОМ!

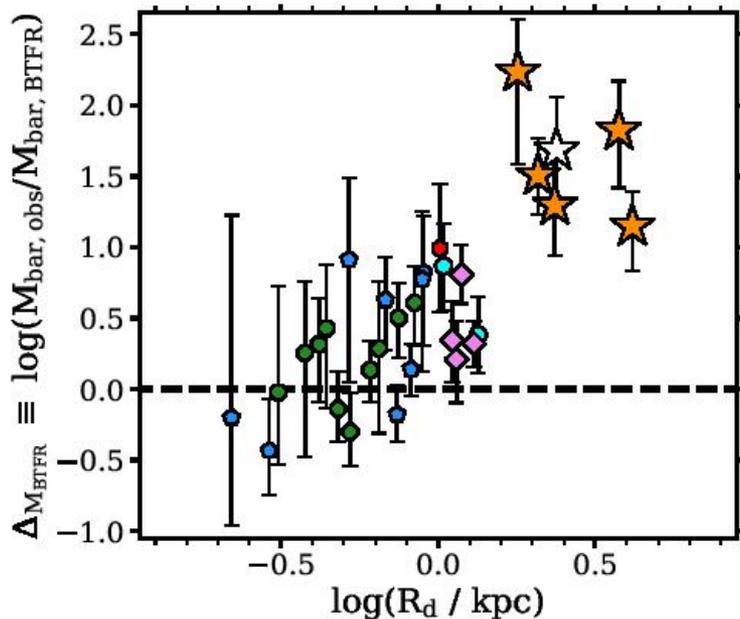


Figure 10. Disc scale length vs. vertical distance from the BTFR, for galaxies of different samples with $15 \text{ km s}^{-1} < V_{\text{circ}} < 45 \text{ km s}^{-1}$. Symbols are as in Figure 9 and the dashed line represents no offset from the SPARC BTFR. A correlation between both parameters is observed, with larger galaxies falling systematically above the BTFR. Some samples have no reported uncertainty in R_d , so we do not plot any horizontal error-bar for consistency.

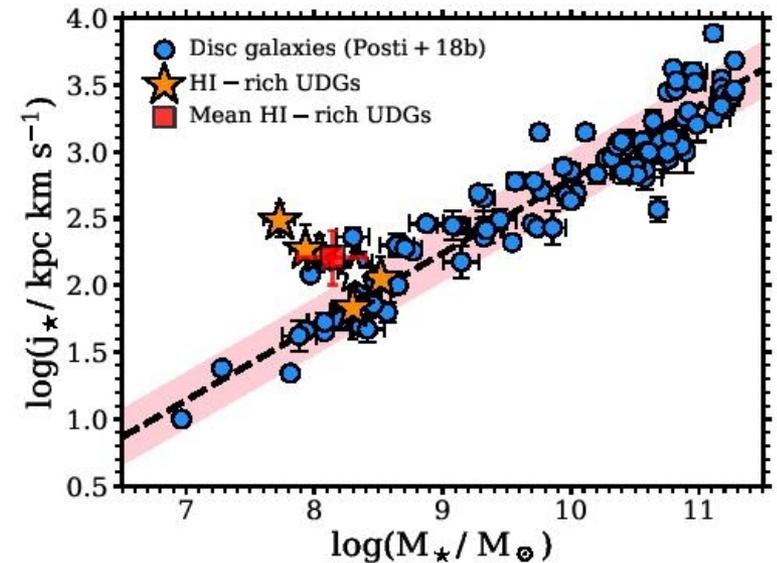


Figure 11. Stellar specific angular momentum–mass relation. Orange stars show our UDGs (AGC 749290 is in white as in Figure 9) and the red square their mean position. Blue circles show the sample analyzed by [Posti et al. \(2018b\)](#), while the black dashed line and the pink band are their best-fit relation and its 1σ scatter, respectively.

Сценарий

- По совокупности данных (карлики, без темной материи, изолированные, с холодными газовыми дисками) выживает только сценарий неэффективного feedback'a!