The Atomic Gas Mass of Green Pea Galaxies

N. KANEKAR,[1] T. GHOSH,[2] J. RHOADS,[3,4] S. MALHOTRA,[3,4] S. HARISH,[4] J. N. CHENGALUR,[1] AND K. M. JONES[5]

[1]*National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, Pune University, Pune 411007, India*
[2]*Green Bank Observatory, P.O. Box 2, Green Bank, WV 24944, USA*
[3]*Astrophysics Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA*
[4]*School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, USA*
[5]*Department of Physics and Astronomy, University of Kansas, 1082 Malott, 1251 Wescoe Hall Dr. Lawrence, KS 66045*

ABSTRACT

We have used the Arecibo Telescope and the Green Bank Telescope to carry out a deep search for HI 21 cm emission from a large sample of Green Pea galaxies, yielding 19 detections, and 21 upper limits on the HI mass. We obtain HI masses of $\mathrm{M_{HI}} \approx (4 - 300) \times 10^8\,\mathrm{M_\odot}$ for the detections, with a median HI mass of $\approx 2.6 \times 10^9\,\mathrm{M_\odot}$; for the non-detections, the median 3σ upper limit on the HI mass is $\approx 5.5 \times 10^8\,\mathrm{M_\odot}$. These are the first estimates of the atomic gas content of Green Pea galaxies. We find that the HI-to-stellar mass ratio in Green Peas is consistent with trends identified in star-forming galaxies in the local Universe. However, the median HI depletion timescale in Green Peas is ≈ 0.6 Gyr, an order of magnitude lower than that obtained in local star-forming galaxies. This implies that Green Peas consume their atomic gas on very short timescales. A significant fraction of the Green Peas of our sample lie $\gtrsim 0.6$ dex (2σ) above the local $\mathrm{M_{HI}} - \mathrm{M_B}$ relation, suggesting recent gas accretion. Further, $\approx$ 30% of the Green Peas are more than $\pm 2\sigma$ deviant from this relation, suggesting possible bimodality in the Green Pea population. We obtain a low HI 21 cm detection rate in the Green Peas with the highest O32 $\equiv$ [OIII]λ5007/[OII]λ3727 luminosity ratios, O32 > 10, consistent with the high expected Lyman-continuum leakage from these galaxies.

Keywords: Galaxies — 21cm line emission — Galaxy masses

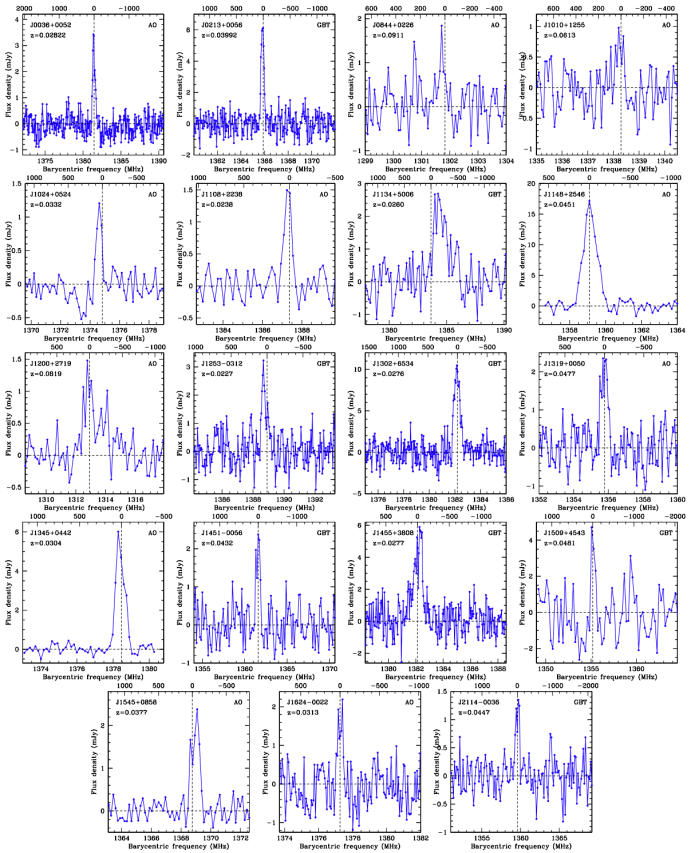
This paper is dedicated to the Arecibo Observatory and its people.
De estas calles que ahondan el poniente,
Una habrá (no sé cual) que he recorrido,
Ya por última vez, ...[1]

Одним из утопающих в закате
Проулков - но которым? - в этот час,
Ещё не зная о своей утрате,
Прошёл я, может быть, в последний раз.
...
(Пределы
Х.Л.Борхес; пер. Б.Дубина)

44 Green Peas, $z \approx 0.02 - 0.1$
$-20.0 \leq M_B \leq -16.1$
$7.6 \leq 12+[O/H] \leq 8.35$

Arecibo Telescope, Green Bank Telescope

Только для 19 галактик удалось детектировать сигнал в линии 21см



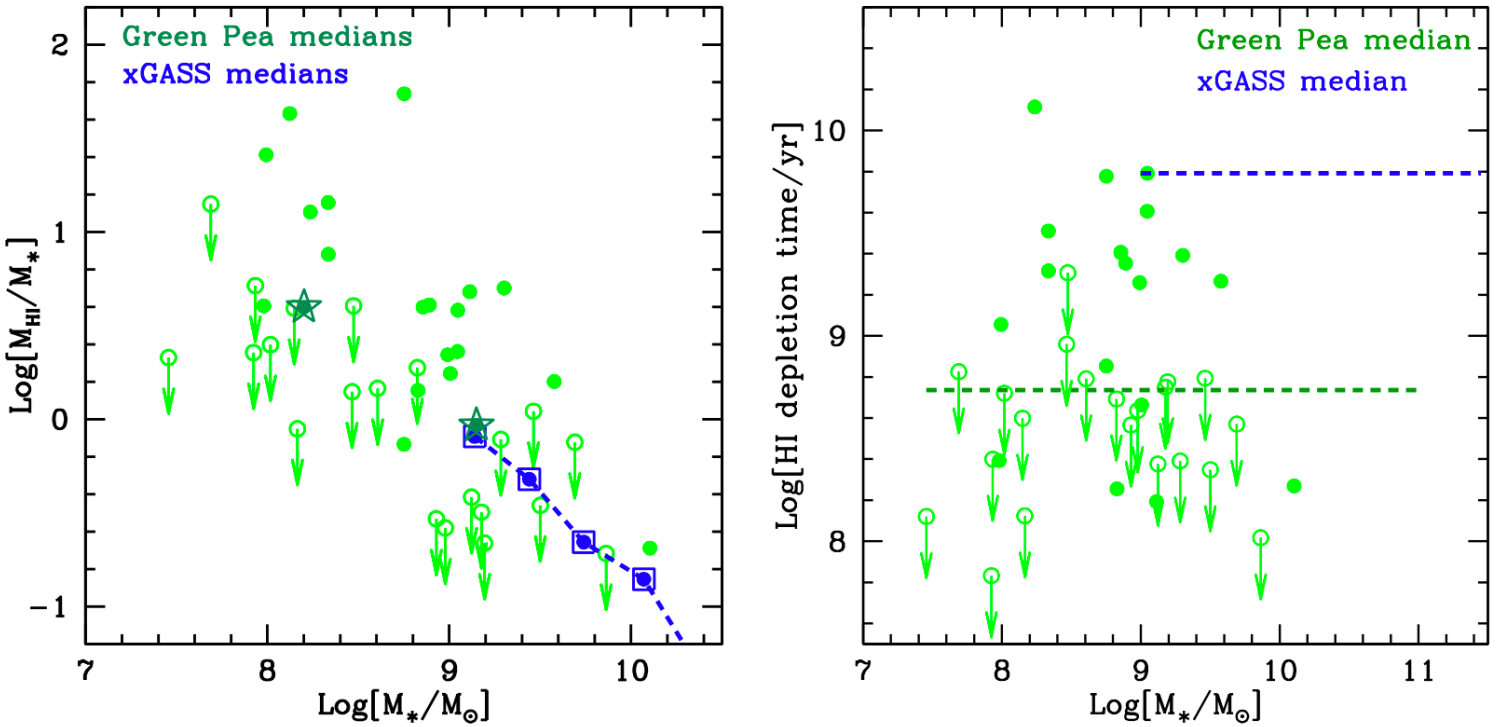


Figure 2. [A] The HI-to-stellar mass ratio $f_{\rm HI} \equiv {\rm M_{HI}/M_\star}$ plotted against the stellar mass $\rm M_\star$, for the 40 Green Peas. Detections of HI 21cm emission are shown as filled (green) circles, and non-detections as open circles with downward-pointing arrows. The two dark green stars show the median values of $f_{\rm HI}$ in two stellar mass bins. The filled blue circles indicate the median values of $f_{\rm HI}$ in the xGASS sample (Catinella et al. 2018). [B] The HI depletion time, $\tau_{\rm dep}$, plotted against the stellar mass $\rm M_\star$ for the Green Pea galaxies. The dashed lines indicate the median HI depletion timescales for the Green Peas (green) and galaxies from the xGASS sample (blue; Saintonge et al. 2017). The median HI depletion timescale of the Green Peas is seen to be an order of magnitude lower than that of the xGASS galaxies.

$\tau_{dep,med} \approx 0.58$ Gyr
(Для выборки xGASS ≈ 6 Gyr)

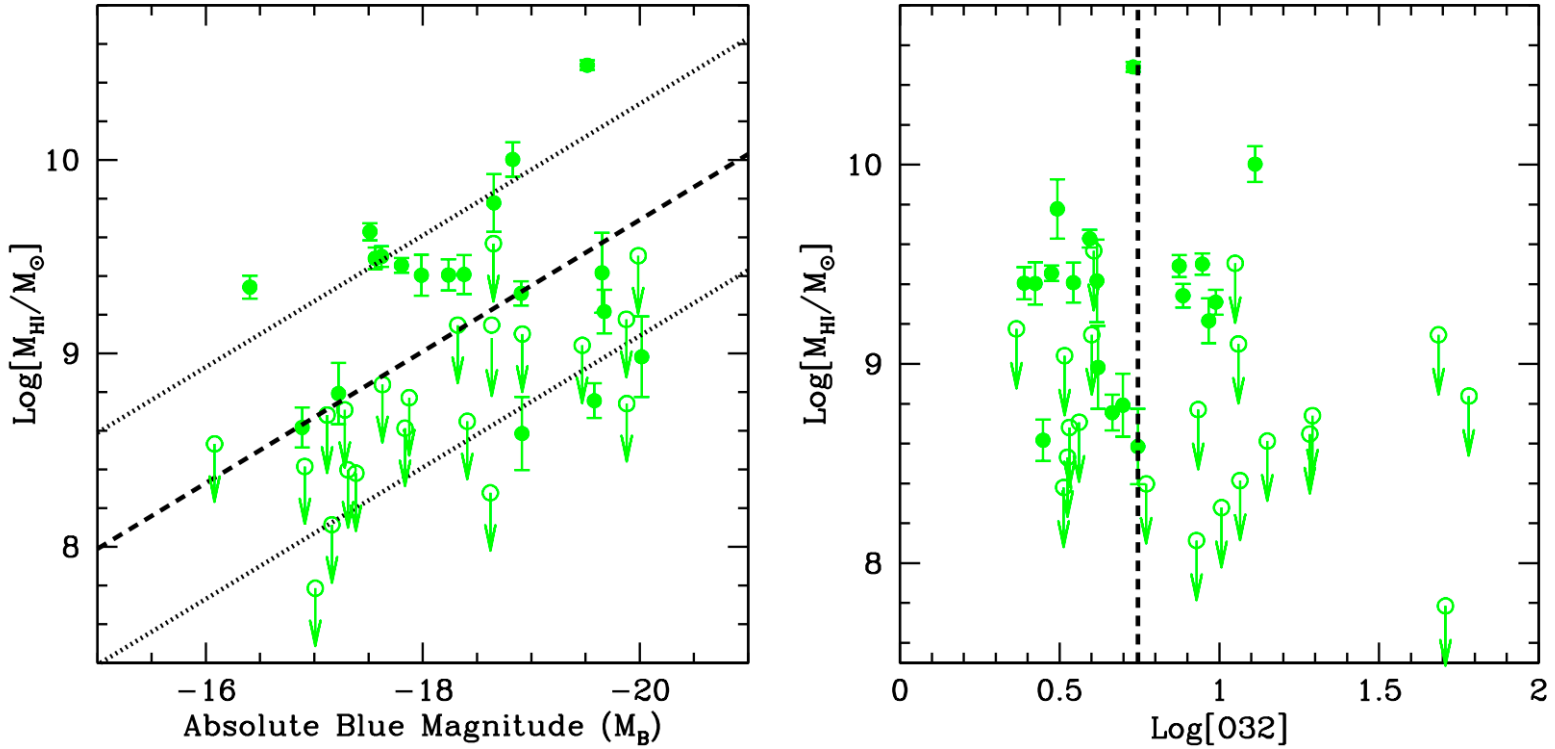


Figure 3. The HI mass of the Green Peas plotted against [A] their absolute B-magnitude, M_B, and [B] their O32 value. In [A], the dashed line indicates the $M_{HI} - M_B$ relation in the local Universe, while the dotted lines indicate the ± 0.6 dex (i.e. $\pm 2\sigma$) spread around the relation (Dénes et al. 2014). A number of the Green Peas are seen to have HI masses $\gtrsim +0.6$ dex above the local relation, while a few have HI masses $\gtrsim 0.6$ dex below the relation. In [B], the dashed vertical line indicates the median O32 value, ≈ 5.5.

Для 8 галактик есть спектральные данные в области Ly-alpha, но никакой зависимости доли утекающих квантов от содержания газа не нашли (хотя выборка мала).
Зависимости M_{HI}, M_{HI}/M_{stars}, τ_{dep} от металличности также не нашли.

Для галактик с O32>10 – в среднем M_{HI} в среднем ниже (хотя выборка мала), что согласуется с ожидаемой картиной.

MeerKAT-64 discovers wide-spread tidal debris in the nearby NGC 7232 galaxy group

B. Namumba,[1]★ B. S. Koribalski,[2,3] G. I. G. Józsa,[4,1] K. Lee-Waddell,[2] M. G. Jones,[5,16] C. Carignan,[6,7,8] L. Verdes-Montenegro,[5] R. Ianjamasimanana,[1,4] W. J. G. de Blok,[9,6,10] M. Cluver,[11] J. Garrido,[5] S. Sánchez-Expósito[5] A. J. T. Ramaila,[4] K. Thorat,[12] L. A. L. Andati,[1] B. V. Hugo,[1,4] D. Kleiner,[13] P. Kamphuis,[14] P. Serra,[13] O. M. Smirnov,[1,4] F. M. Maccagni,[13] S. Makhathini,[17] D. Cs. Molnár,[13] S. Perkins,[4] M. Ramatsoku,[1,13] S. V. White,[1] F. Loi,[13]

[1]*Department of Physics and Electronics, Rhodes University, PO Box 94, Makhanda, 6140, South Africa*
[2]*Australia Telescope National Facility, CSIRO Astronomy and Space Science, P.O. Box 76, NSW 1710, Epping, Australia*
[3]*Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia*
[4]*South African Radio Astronomy Observatory, Black River Park, 2 Fir Street, Observatory, Cape Town, 7925, South Africa*
[5]*Instituto de Astrofísica de Andalucía (CSIC), Glorieta de la Astronomía, 18008 Granada, Spain*
[6]*Department of Astronomy, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa*
[7]*Département de physique, Université de Montréal, C.P. 6128, Succ. centre-ville, Montréal, Québec, Canada, H3C 3J7*
[8]*Observatoire d'Astrophysique de l'Université de Ouagadougou, BP 7021, Ouagadougou 03, Burkina Faso*
[9]*Netherlands Institute for Radio Astronomy (ASTRON), Oude Hoogeveensedijk 4, 7991 PD Dwingeloo, The Netherlands*
[10]*Kapteyn Astronomical Institute, University of Groningen, Postbus 800, 9700 AV Groningen, The Netherlands*
[11]*Centre for Astrophysics and Supercomputing, Swinburne University of Technology, Hawthorn, Victoria 3122, Australia*
[12]*Department of Physics, University of Pretoria, Hatfield, Pretoria, 0028, South Africa*
[13]*INAF - Osservatorio Astronomico di Cagliari, Via della Scienza 5, I-09047 Selargius (CA), Italy*
[14]*Ruhr University Bochum, Faculty of Physics and Astronomy, Astronomical Institute, 44780 Bochum, Germany*
[15]*Department of Physics and Astronomy, University of the Western Cape, Robert Sobkwe Road, Bellville, 7535, South Africa*
[16]*Steward Observatory, University of Arizona, 933 North Cherry Avenue, Rm. N204, Tucson, AZ 85721-0065, USA*
[17] *School of Physics, University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg, South Africa*

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ABSTRACT

We report the discovery of large amounts of previously undetected cold neutral atomic hydrogen (H I) around the core triplet galaxies in the nearby NGC 7232 galaxy group with MeerKAT. With a physical resolution of ~1 kpc, we detect a complex web of low surface brightness H I emission down to a 4σ column density level of $\sim 1 \times 10^{19}$ cm^{-2} (over 44 km s^{-1}). The newly discovered H I streams extend over ~20 arcmin corresponding to 140 kpc in projection. This is ~3 times the H I extent of the galaxy triplet (52 kpc). The H I debris has an H I mass of $\sim 6.6 \times 10^9$ M$_\odot$, more than 50% of the total H I mass of the triplet. Within the galaxy triplet, NGC 7233 and NGC 7232 have lost a significant amount of H I while NGC 7232B appears to have an excess of H I. The H I deficiency in NGC 7232 and NGC 7233 indicates that galaxy-galaxy interaction in the group concentrates on this galaxy pair while the other disc galaxies have visited them over time. In comparison to the AMIGA sample of isolated galaxies we find that with regards to its total H I mass the NGC 7232/3 galaxy triplet is not H I deficient. Despite the many interactions associated to the triplet galaxies, no H I seems to have been lost from the group (yet).

Key words: galaxies: groups: individual: NGC 7232 — galaxies: interactions — galaxies: intergalactic medium — radio lines: galaxies — techniques: interferometric

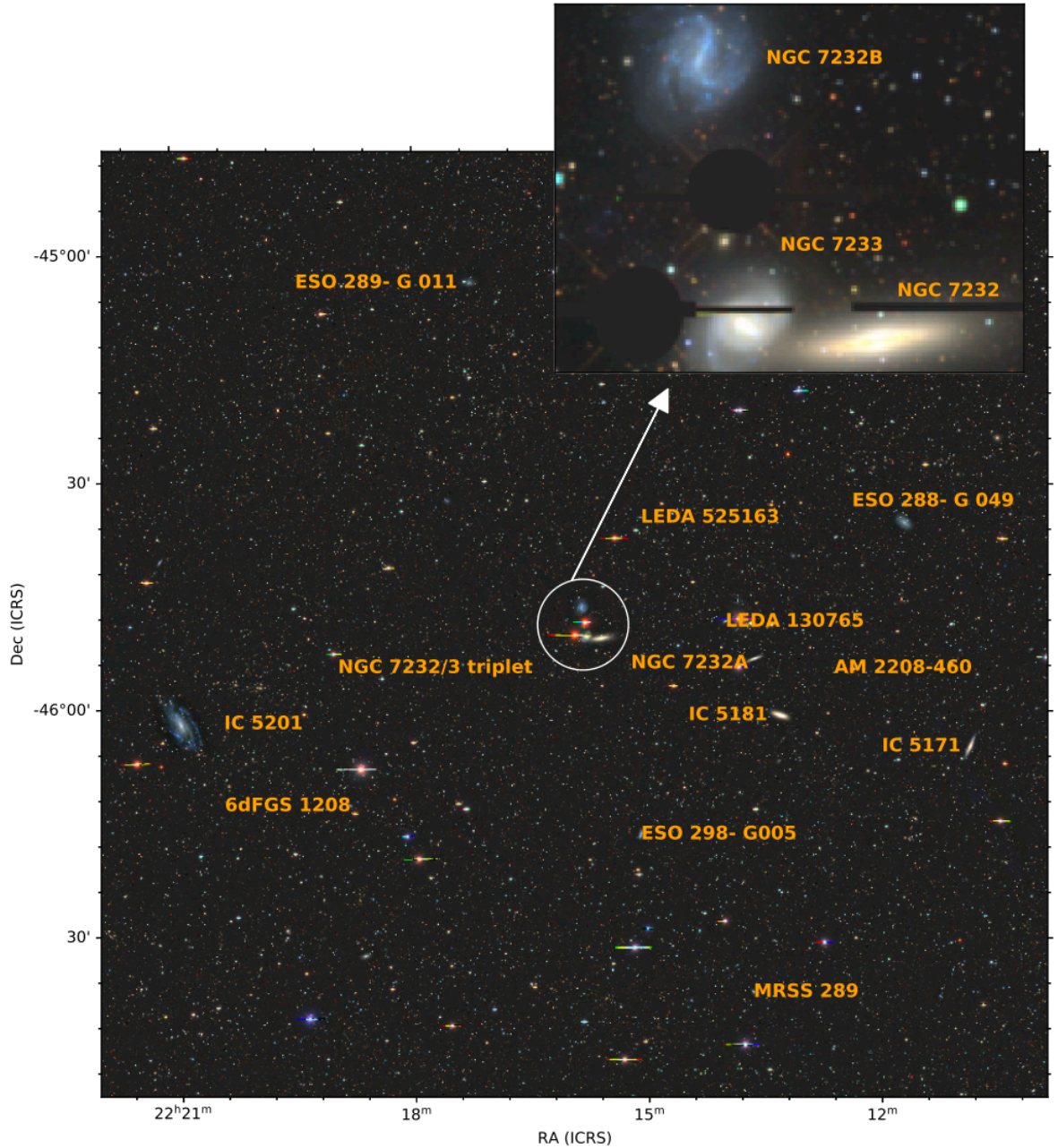

Figure 1. Three-colour (grz) optical image of the NGC 7232 group from the Dark Energy Legacy Survey with the MeerKAT H I detected galaxies labelled. The white circle indicates the NGC 7232/3 galaxy triplet. The top panel shows the NGC 7232/3 galaxy triplet with bright foreground stars and related artifacts obscured.

≤ 10^{20} cm^{-2}

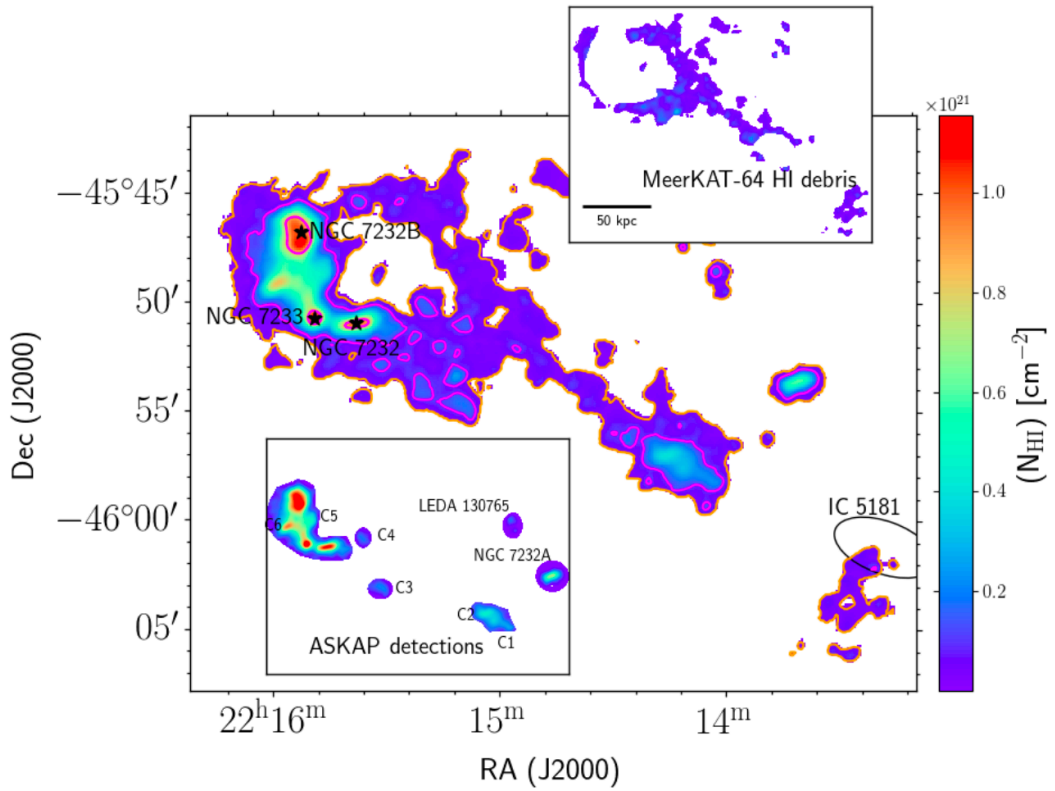

Figure 3. MeerKAT-64 H I column density map (primary beam corrected) of the NGC 7232/3 triplet and its surrounding environment over a velocity range of ~ 1606 to 2232 km s^{-1}. The black stars indicate the optical centers of the triplet galaxies. Known galaxies and previously identified H I clouds (Lee-Waddell et al. 2019) are shown in the **bottom left inset panel**. The lenticular galaxy, IC 5181 (v_{opt} = 1987 km s^{-1}), marked in an ellipse, is not detected in H I. — **Main panel:** The H I column density contour levels are $4\sigma \times (1, 16, 80)$, where the 4σ column density limit is 1×10^{19} cm^{-2}. The colours represent H I column density levels of $\geq 10^{20}$ cm^{-2} (magenta) and 1×10^{19} cm^{-2} (orange). The MeerKAT detected H I debris are shown in the **top right inset panel**.

Удалось детектировать ~ в 5 раз больше HI низкой плотности, чем с ASCAP

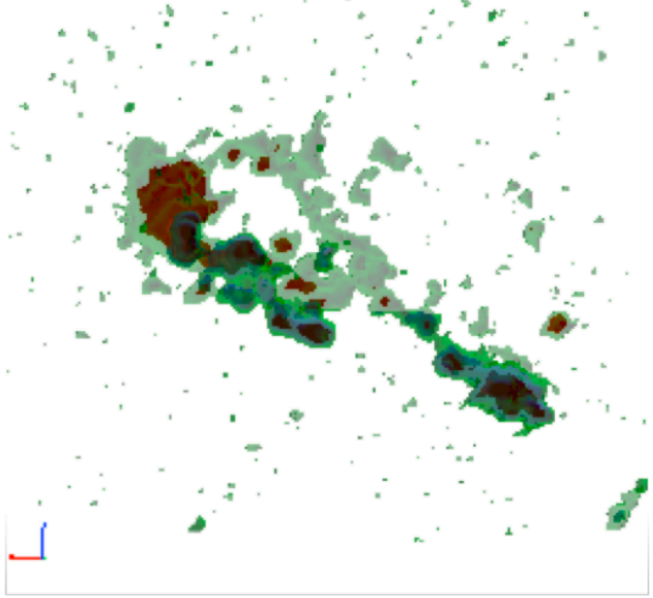

Figure 4. 3D representation of the H I around the galaxy triplet and its surrounding environment. The green components represent the low column density H I emission, blue colour show the intermediate column density structures, and the red components represent the high column density regions. This must be viewed using Adobe Acrobat.

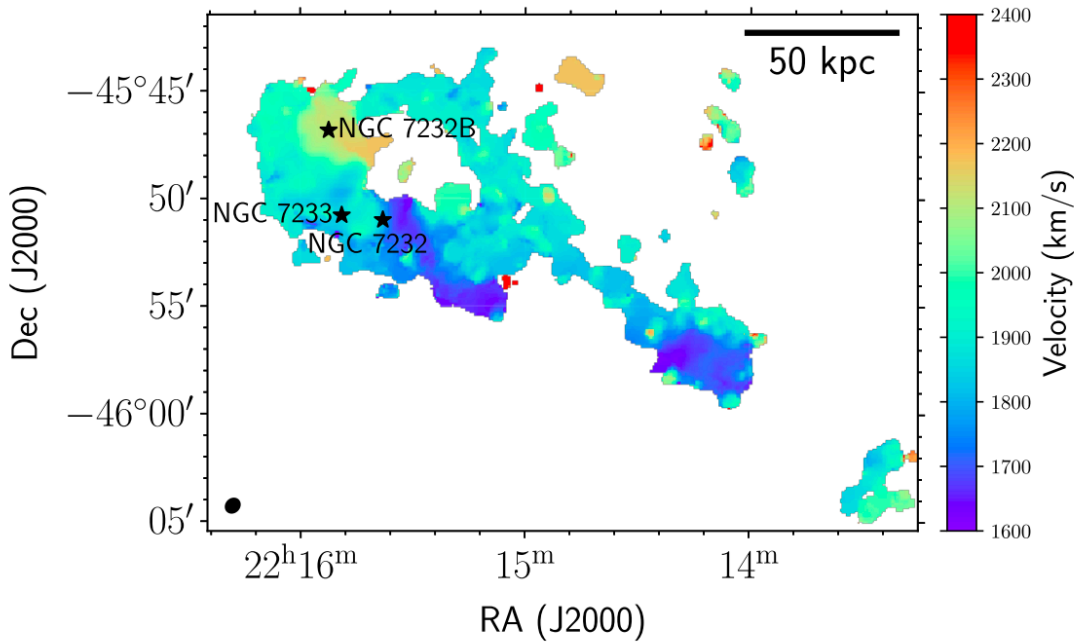

Figure 5. MeerKAT-64 H I velocity field map of the NGC 7232/3 triplet. The black stars indicate the optical centers of the triplet galaxies.

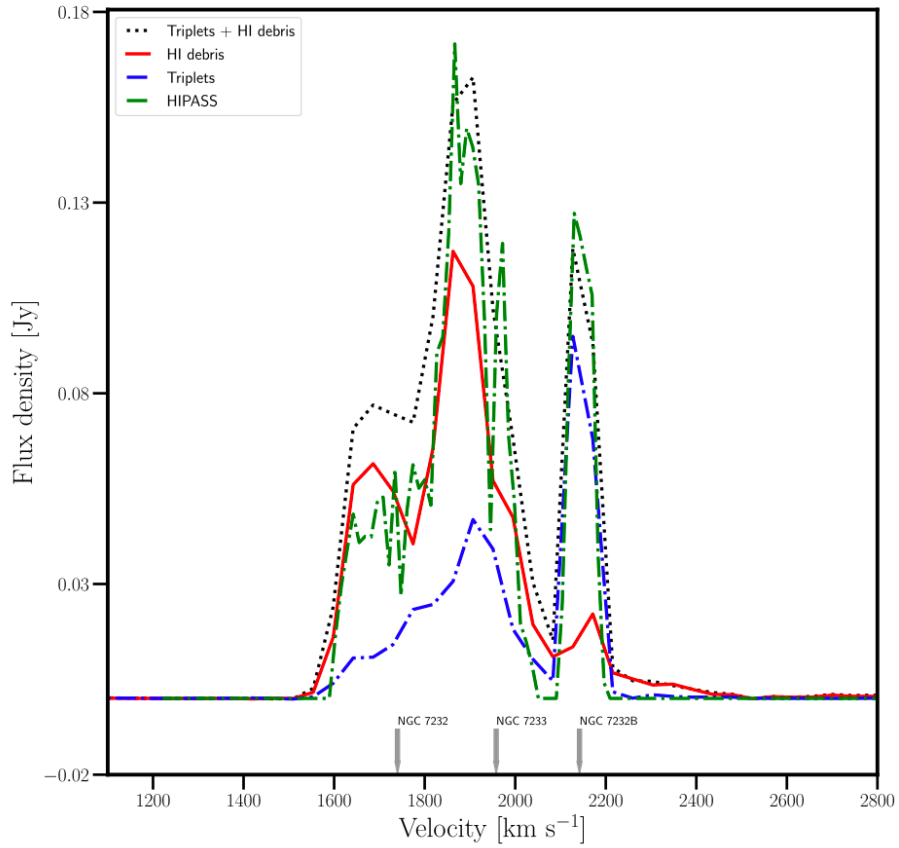

Figure 6. MeerKAT-64 H I global profile of both the NGC 7232/3 triplet and surrounding H I debris (black dotted line), the H I debris alone (red solid line), the galaxy triplet (blue dashed-dotted line) and the HIPASS global profile (green dashed-dotted line). The HIPASS global profile was extracted after applying a 4σ threshold to the cube.

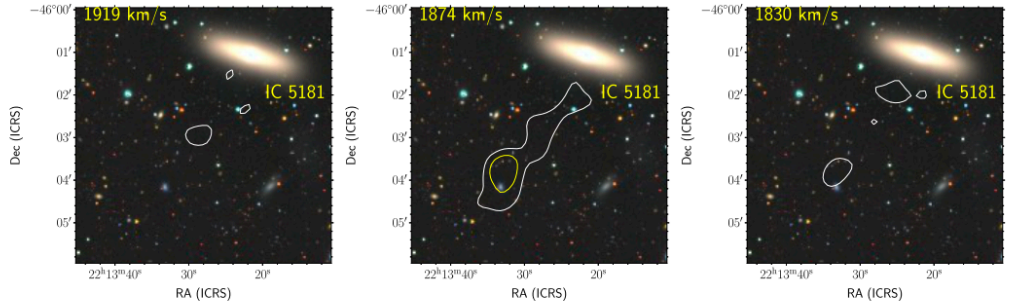

Figure 7. MeerKAT-64 channel maps (primary beam corrected) showing the H I cloud near the gas poor lenticular galaxy IC 5181. The channel maps are overlaid on the DECaLS grz-band image. The contour colours are in increasing order with: white (1×10^{19} cm^{-2}) and yellow (2.6×10^{19} cm^{-2}), where (1×10^{19} cm^{-2}) represent a 4σ detection limit in the MeerKAT-64 H I cube. The channel velocity is shown in the top left corner.

>50% газа – в межгалактической среде!