

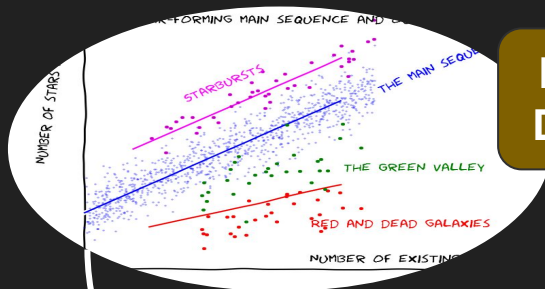
Evidence for Distinct Gas and Dust Evolution in Quiescent Galaxies

G. Lorenzon¹, D. Donevski¹², A. W. S. Man³, M. Romano⁴⁵, K. E. Whitaker⁶, S. Belli⁷, D. Liu⁸, M. M. Lee⁹, D. Narayanan¹⁰¹¹, A. Long¹²¹³, I. Shivaei¹⁴, **A. Nanni¹¹⁵, K. Lisiecki¹**, P. Sawant¹, G. Rodighiero¹⁶, I. Damjanov¹⁷, Junais¹⁸¹⁹, R. Davé²⁰²¹, C. Pappalardo²², C. Lovell²³, M. Hamed¹⁴

¹ NCBJ Warsaw; ² SISSA Trieste; ³ UBC Vancouver; ⁴ MPIfR Bonn; ⁵ INAF—OAPD Padova; ⁶ UMass Amherst; ⁷ Univ. Bologna; ⁸ Purple Mountain Obs., Nanjing; ⁹ DTU-Space Denmark; ¹⁰ Univ. Florida; ¹¹ DAWN Copenhagen; ¹² Univ. Washington; ¹³ UT Austin; ¹⁴ CAB/INTA Madrid; ¹⁵ INAF—OAA Teramo; ¹⁶ Univ. Padova DFA; ¹⁷ Saint Mary's Univ., Halifax; ¹⁸ IAC La Laguna; ¹⁹ ULL La Laguna; ²⁰ IfA Edinburgh; ²¹ Univ. Western Cape; ²² IA/CEA Lisbon; ²³ ICG Portsmouth

NCBJ, Warsaw, Annual Reporting Seminar - 27/11/2025



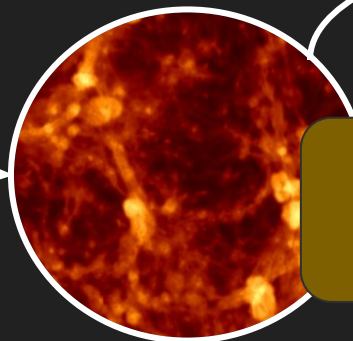
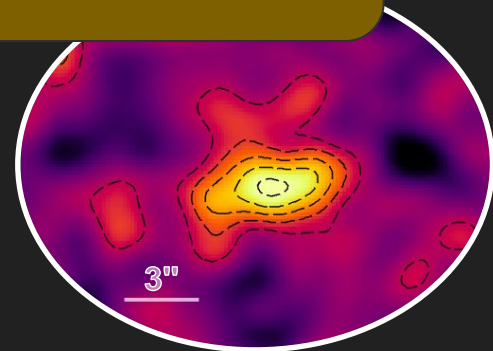


How are Gas and Dust connected ?

What observational evidence do we have?



How does a galaxy stop forming stars?

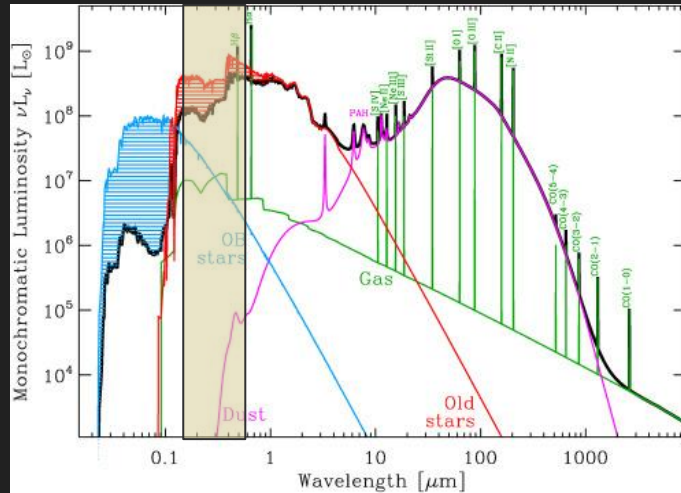


What physics affect Gas and Dust?

The Interstellar Medium

Different phases, different tracers

Inter Stellar Medium

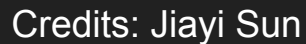
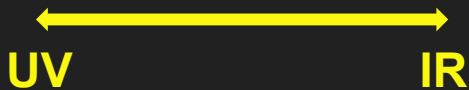


UV $\longleftrightarrow$ IR

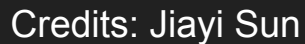
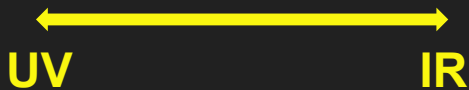


Credits: Jiayi Sun

Inter Stellar Medium

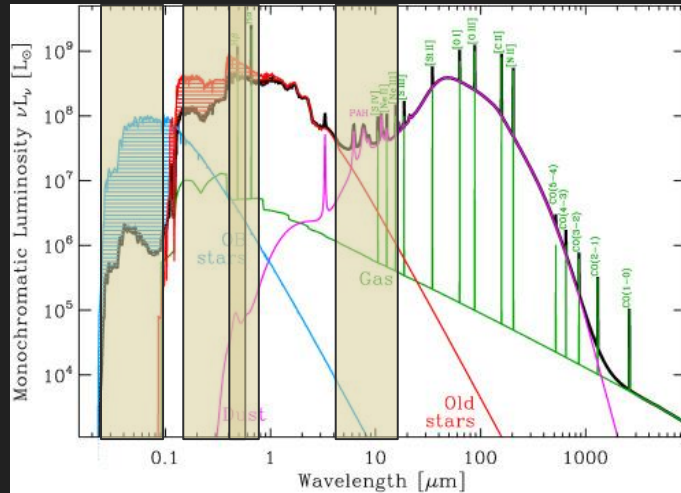


Inter Stellar Medium

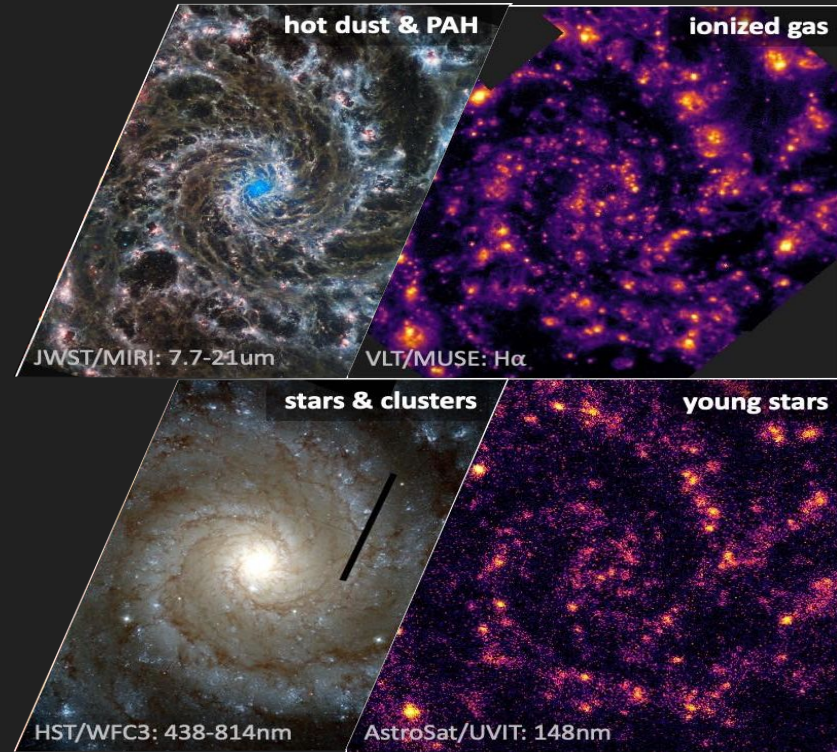


Different phases, different tracers

Inter Stellar Medium

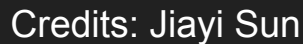
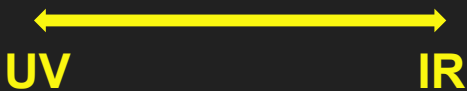


UV $\longleftrightarrow$ IR

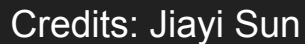
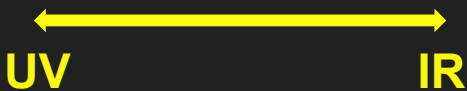


Credits: Jiayi Sun

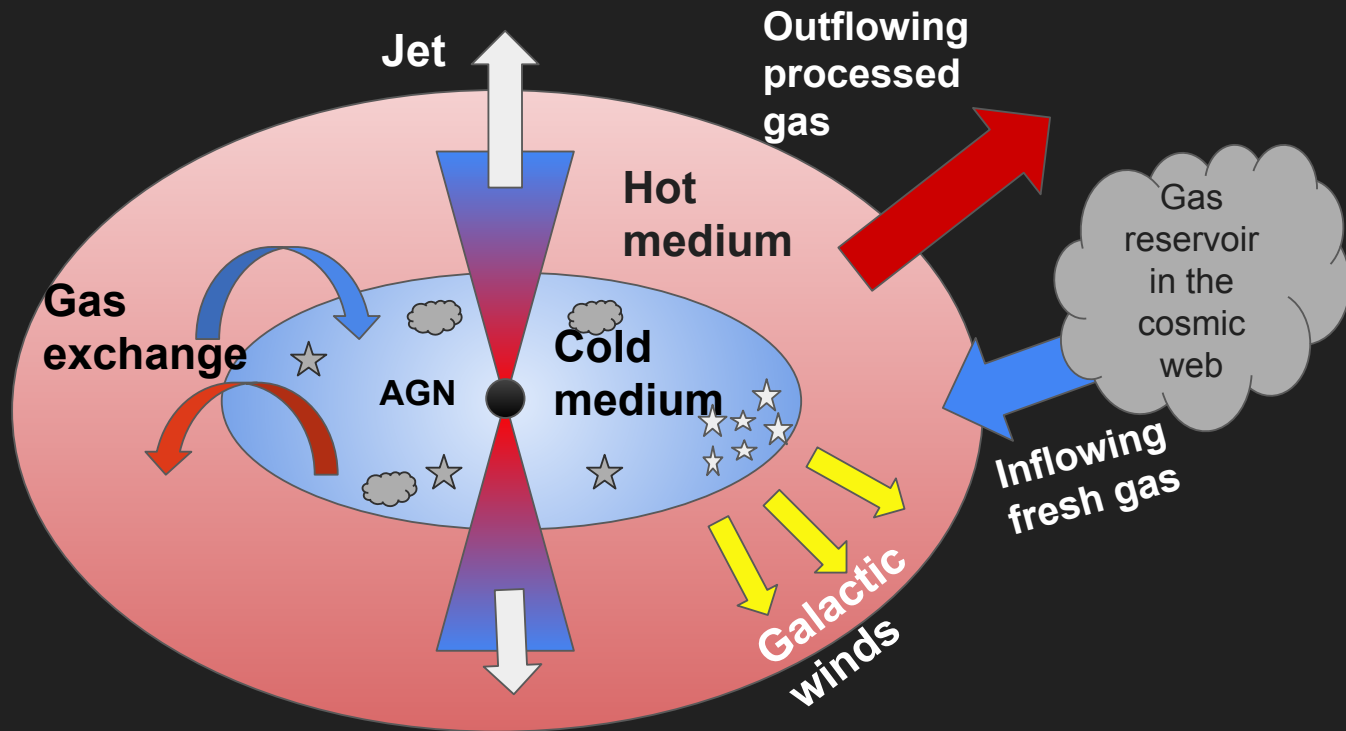
Inter Stellar Medium



Inter Stellar Medium



Baryon cycle: galaxies breathing



Mains sequence and quiescence



Mains sequence and quiescence



Mains sequence and quiescence



Mains sequence and quiescence



Mains sequence and quiescence



Time

Quiescent galaxies



NOT FORMING STARS

OLD

TYPICALLY NO SPIRALS

NO GAS

NO DUST

Quiescent galaxies



NOT FORMING STARS

OLD

TYPICALLY NO SPIRALS

NO GAS

NO DUST

Quiescent galaxies



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TYPICALLY NO SPIRALS

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Quiescent galaxies



NOT FORMING STARS

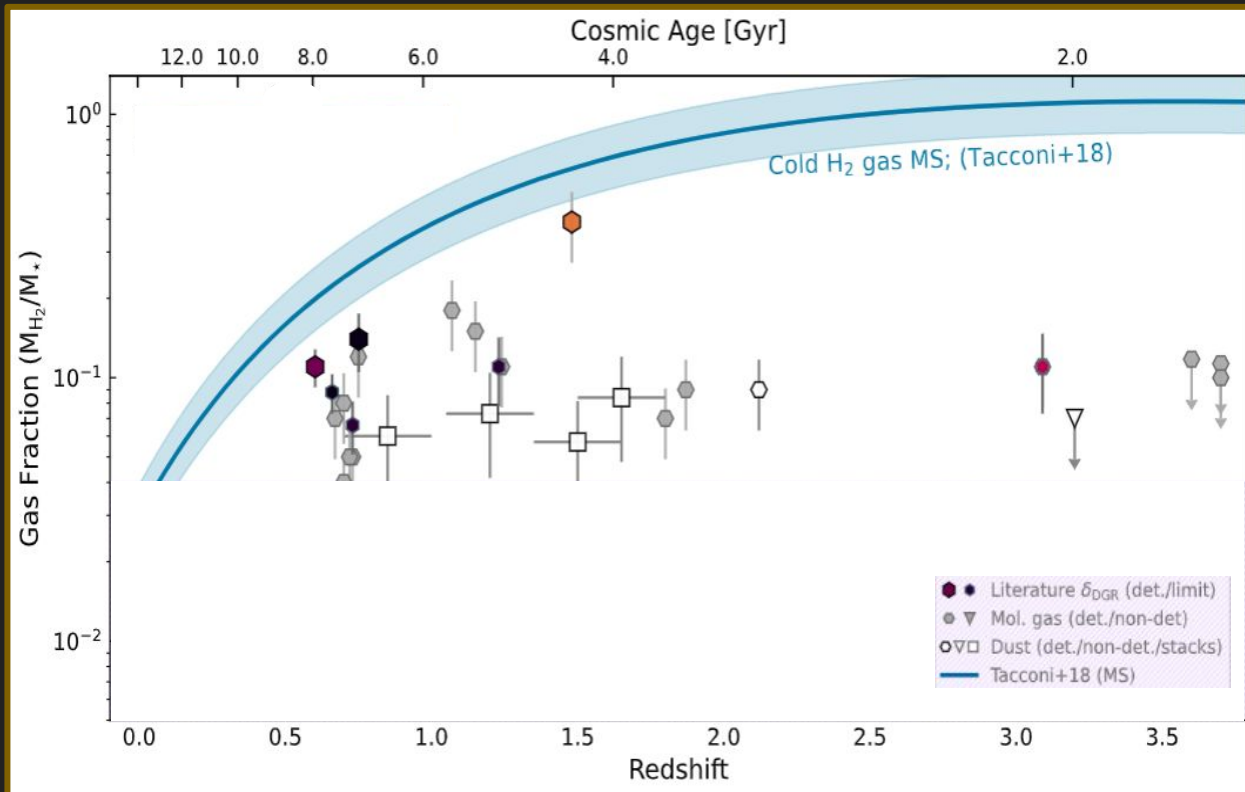
OLD

TYPICALLY NO SPIRALS

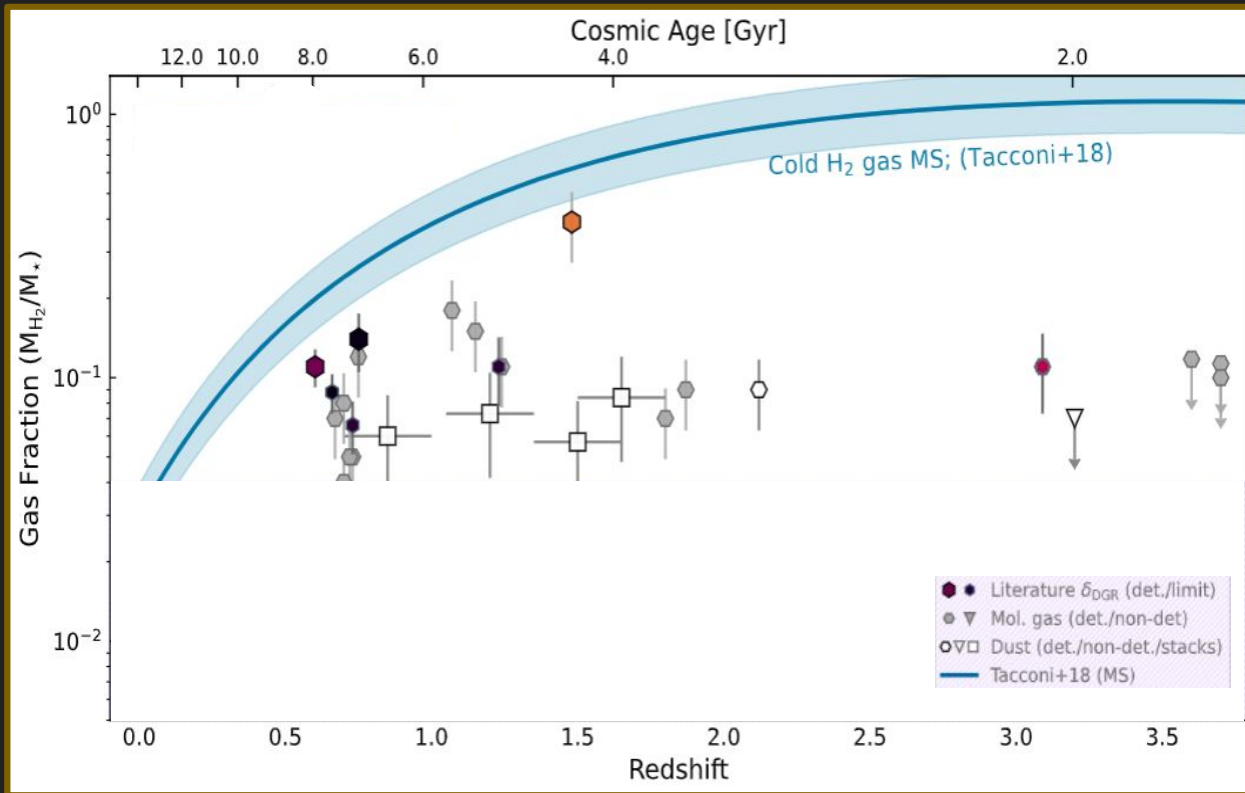
NO GAS

NO DUST

Gas budget over cosmic times

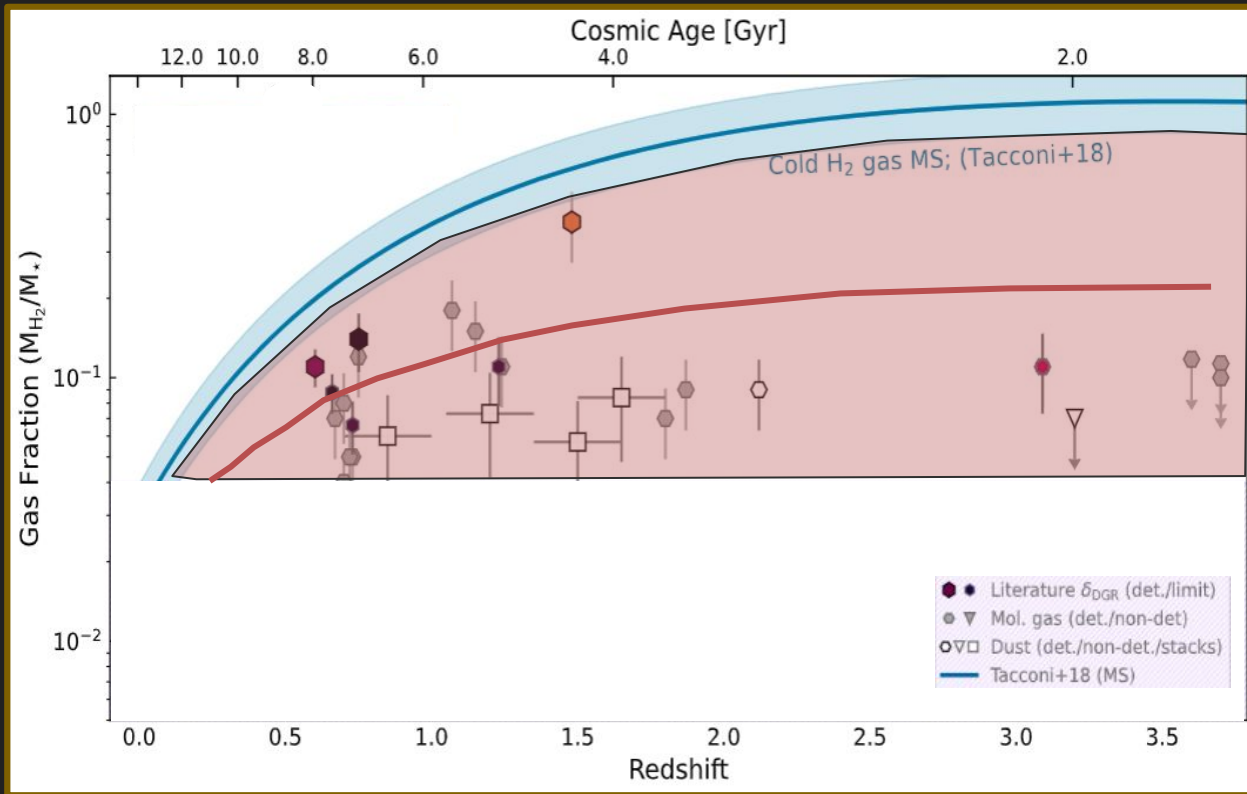


Gas budget over cosmic times



Star forming

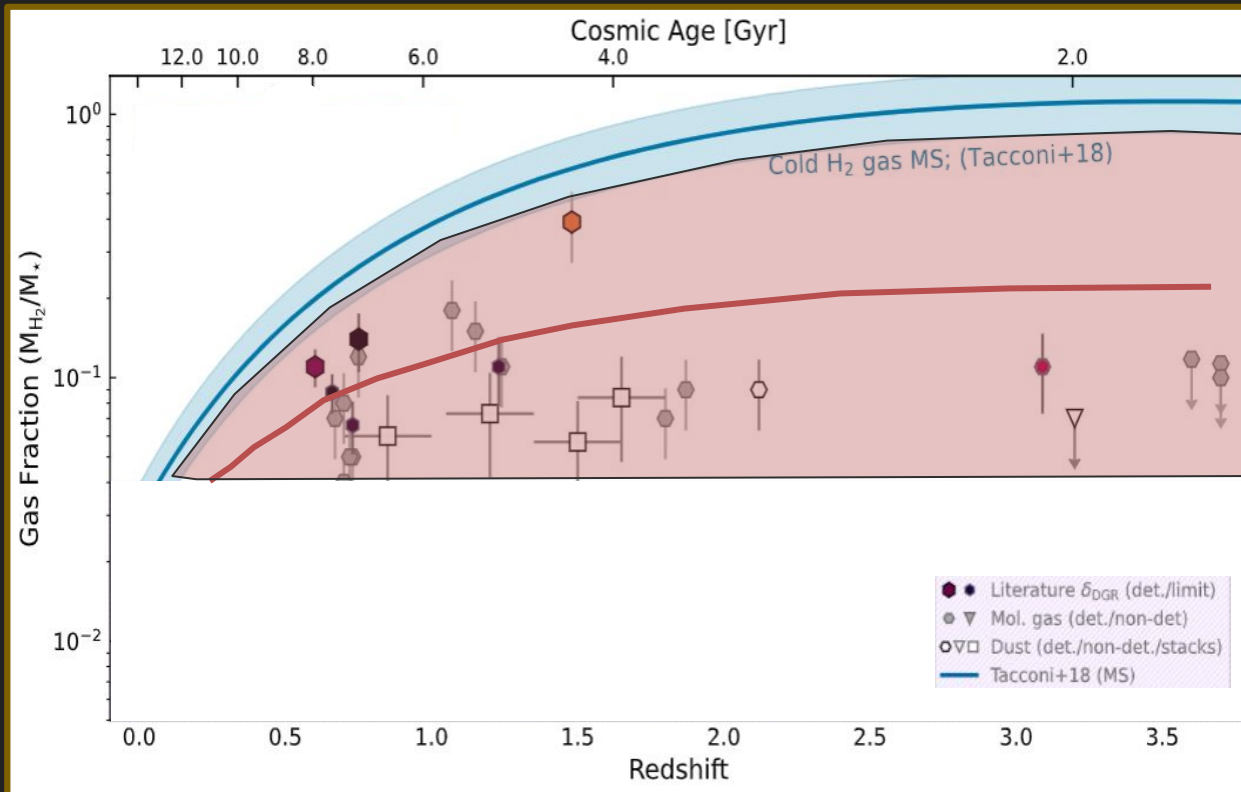
Gas budget over cosmic times



Star forming

Quiescent galaxies (?)

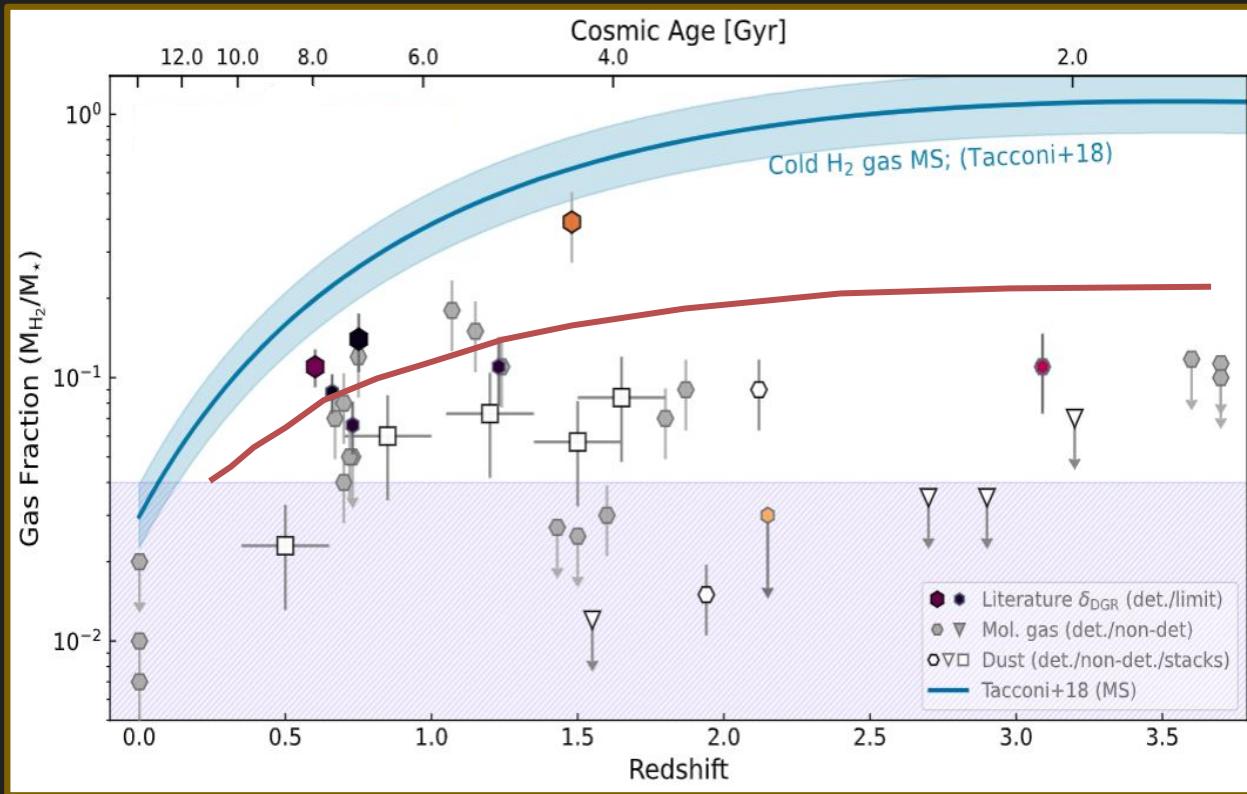
Gas budget over cosmic times



Star forming

2nd Relation (?)

Gas budget over cosmic times



Star forming

2nd Relation
(?)

A lot more to
explore

The DGR: Powers and dangers

$$\frac{M_{\text{dust}}}{M_{\star}} \propto f_{\text{gas}}$$



Very low in quiescent
galaxies (?)

The DGR: Powers and dangers

$$\frac{M_{\text{dust}}}{M_{\star}} \propto f_{\text{gas}}$$



**Easily destroyed if not
supplied by stars (?)**



**Very low in quiescent
galaxies (?)**

The DGR: Powers and dangers

$$\frac{M_{\text{dust}}}{M_{\star}} \propto f_{\text{gas}} \times \delta_{\text{DGR}}(Z_{\text{gas}})$$

The DGR: Powers and dangers

$$\frac{M_{\text{dust}}}{M_{\star}} \propto f_{\text{gas}} \times \delta_{\text{DGR}}(Z_{\text{gas}})$$

The DGR: Powers and dangers

$$\frac{M_{\text{dust}}}{M_{\star}} \propto f_{\text{gas}} \times \delta_{\text{DGR}}(Z_{\text{gas}})$$

No constraint for
quiescent galaxies
!!!

Tracing the evolutionary pathways of dust and cold gas in high-*z* quiescent galaxies with SIMBA

G. Lorenzon^{1,*} , D. Donevski^{1,2} , K. Lisiecki¹ , C. Lovell³, M. Romano^{1,4} , D. Narayanan^{5,6}, R. Davé^{7,8} ,
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G. Rodighiero^{15,4} , and Q. Li¹⁶ 

¹ National centre for Nuclear Research, Pasteura 7, 02-093 Warsaw, Poland

² SISSA, Via Bonomea 265, 34136 Trieste, Italy

³ Institute of Cosmology and Gravitation, University of Portsmouth, Burnaby Road, Portsmouth PO1 3FX, UK

⁴ INAF, OAPD, Vicolo dell'Osservatorio, 5, 35122 Padova, Italy

⁵ Department of Astronomy, University of Florida, 211 Bryant Space Sciences centre, Gainesville, FL, USA

⁶ Cosmic Dawn centre (DAWN), Copenhagen, Denmark

⁷ Institute for Astronomy, Royal Observatory, University of Edinburgh, Edinburgh EH9 3HJ, UK

⁸ Department of Physics & Astronomy, University of the Western Cape, Robert Sobukwe Rd, Bellville 7535, South Africa

⁹ Department of Physics & Astronomy, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada

¹⁰ Department of Astronomy, University of Massachusetts, Amherst, MA 01003, USA

¹¹ INAF – Osservatorio astronomico d'Abruzzo, Via Maggini SNC, 64100 Teramo, Italy

¹² Department of Astronomy, University of Washington, Seattle, WA 98195-1700, USA

¹³ Department of Astronomy, The University of Texas at Austin, 2515 Speedway Boulevard Stop C1400, Austin TX 78712, USA

¹⁴ DTU-Space, Technical University of Denmark, Elektrovej 327, 2800 Kgs. Lyngby, Denmark

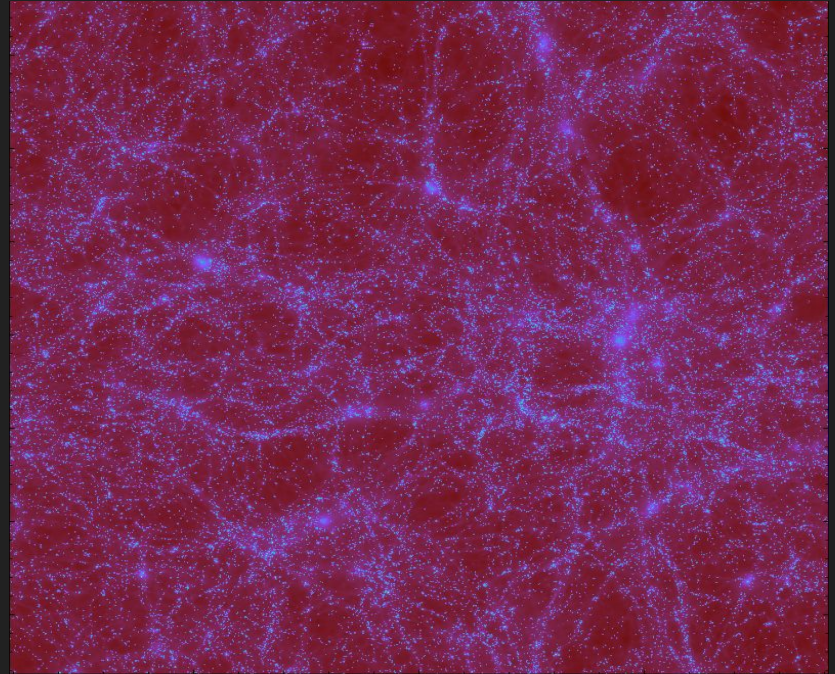
¹⁵ Dipartimento di Fisica e Astronomia, Università di Padova, Vicolo dell'Osservatorio, 3, 35122 Padova, Italy

¹⁶ Max-Planck-Institute für Astrophysik, Karl-Schwarzschild-Strasse 1, 85740 Garching, Germany

¹⁷ Instituto de Astrofísica de Canarias, Vía Láctea S/N, E-38205 La Laguna, Spain

¹⁸ Departamento de Astrofísica, Universidad de La Laguna, E-38206 La Laguna, Spain

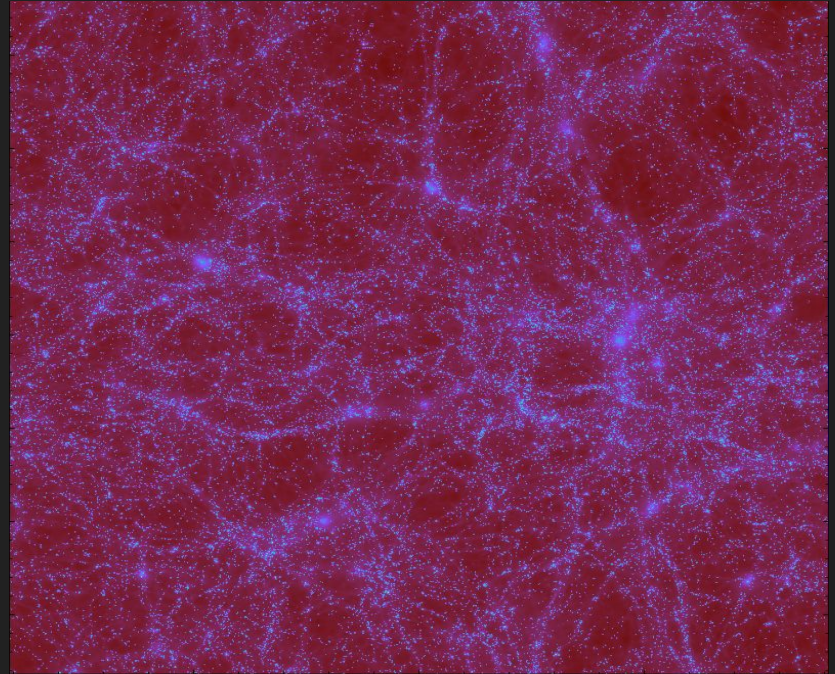
The SIMBA simulation



100 Mpc/h

The SIMBA simulation

**Statistics
+
Physics**



100 Mpc/h

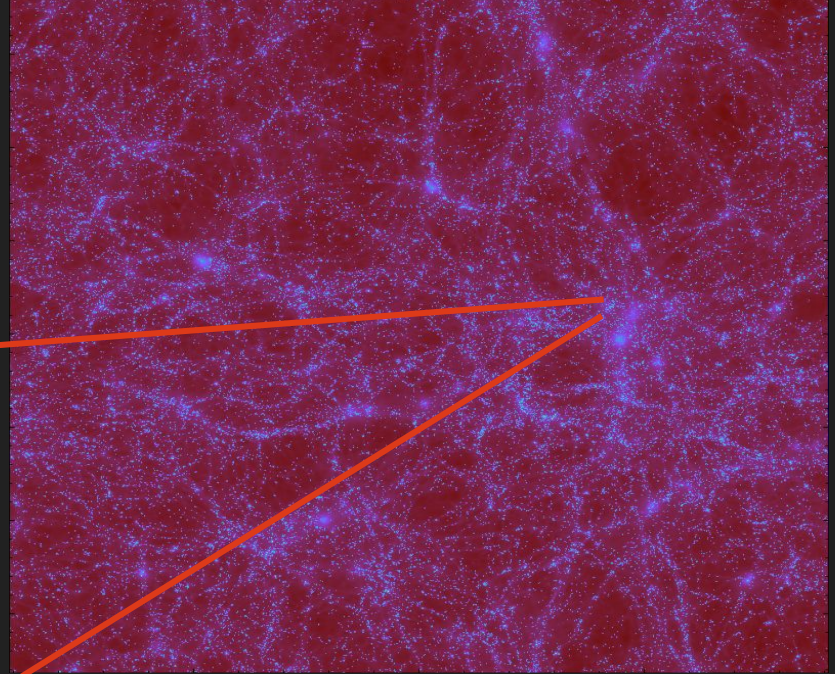
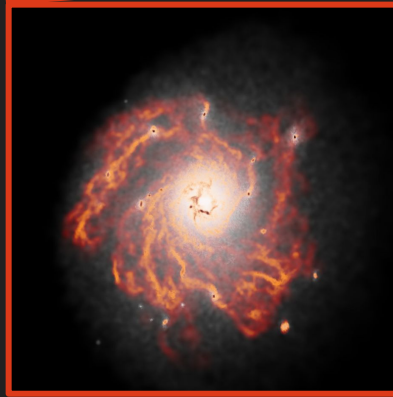
The SIMBA simulation

**Statistics
+
Physics**



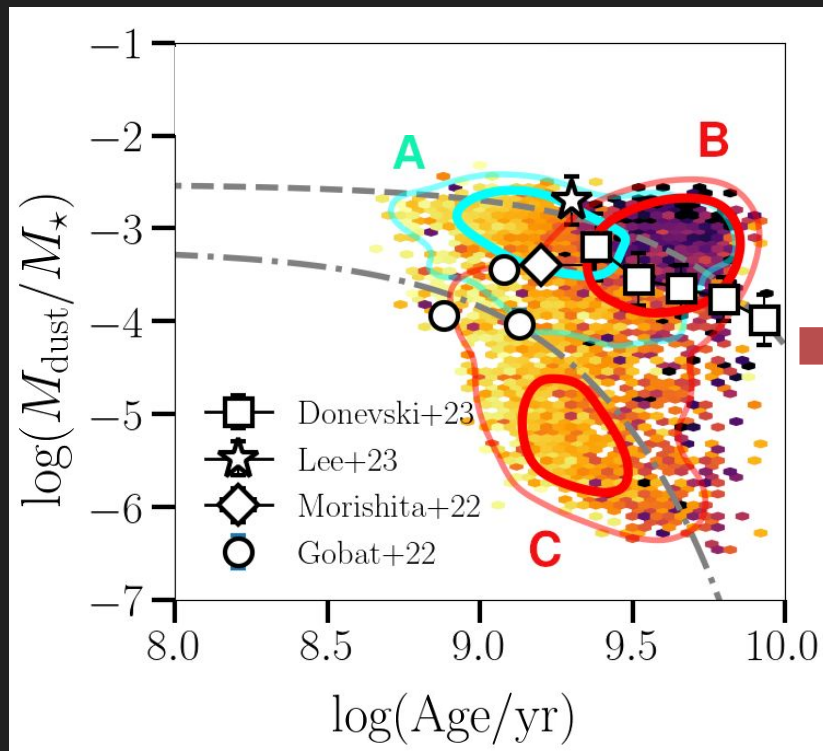
**Stars
+
Gas
+
Dust**

Self-consistency



100 Mpc/h

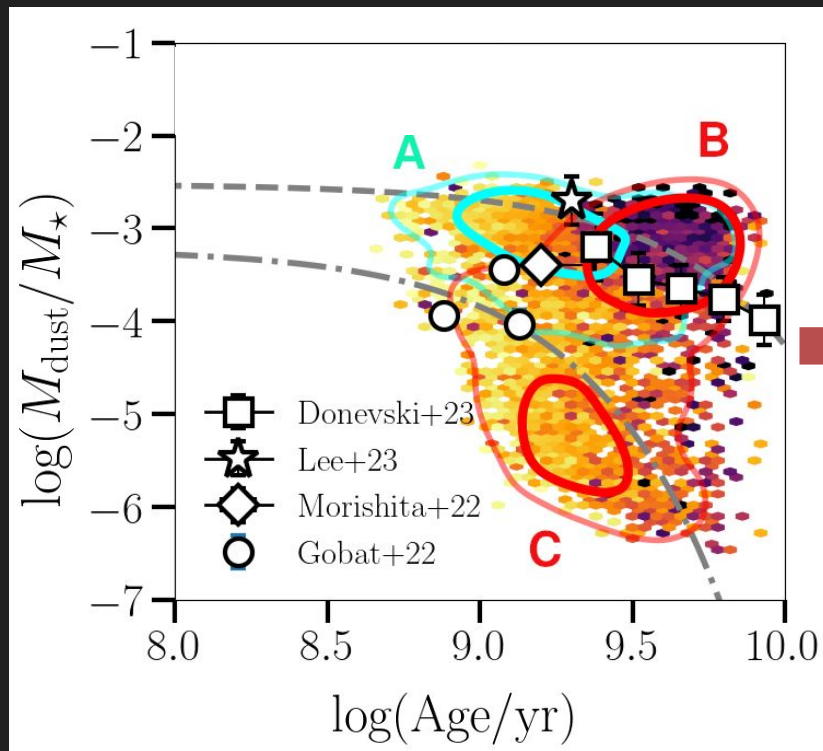
How did quench happened?



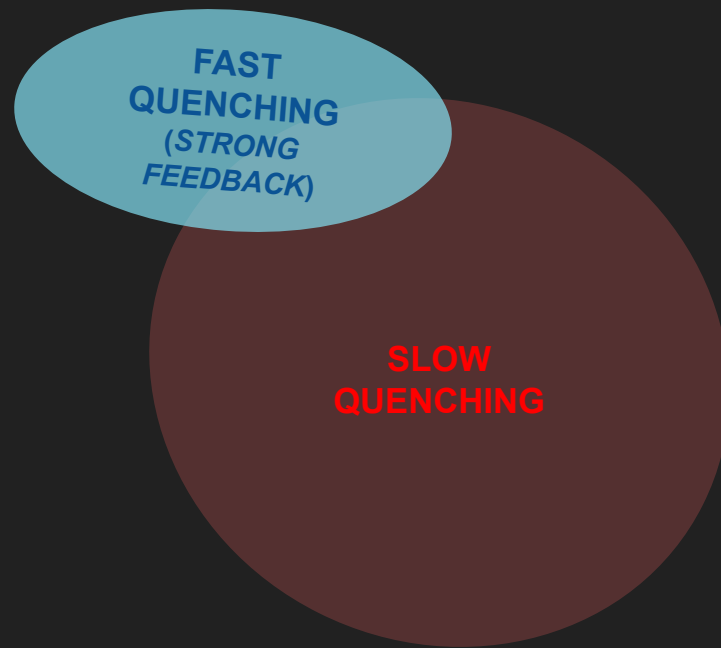
**FAST
QUENCHING
(STRONG
FEEDBACK)**

Lorenzon+25a

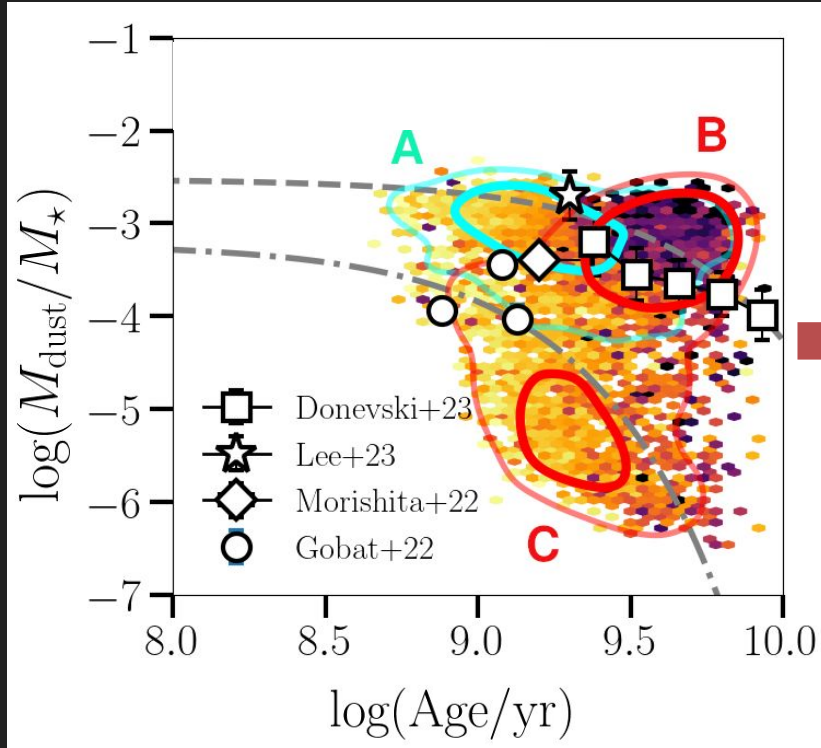
How did quench happened?



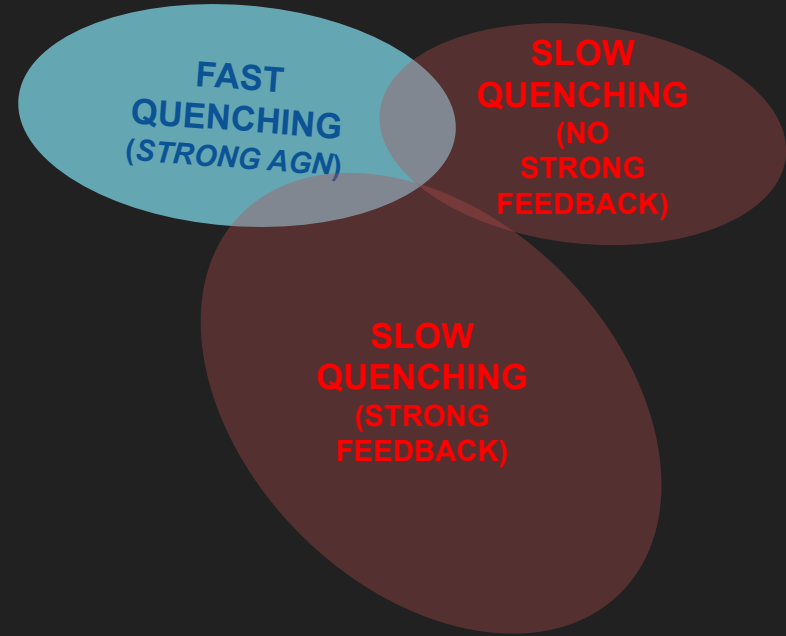
Lorenzon+25a



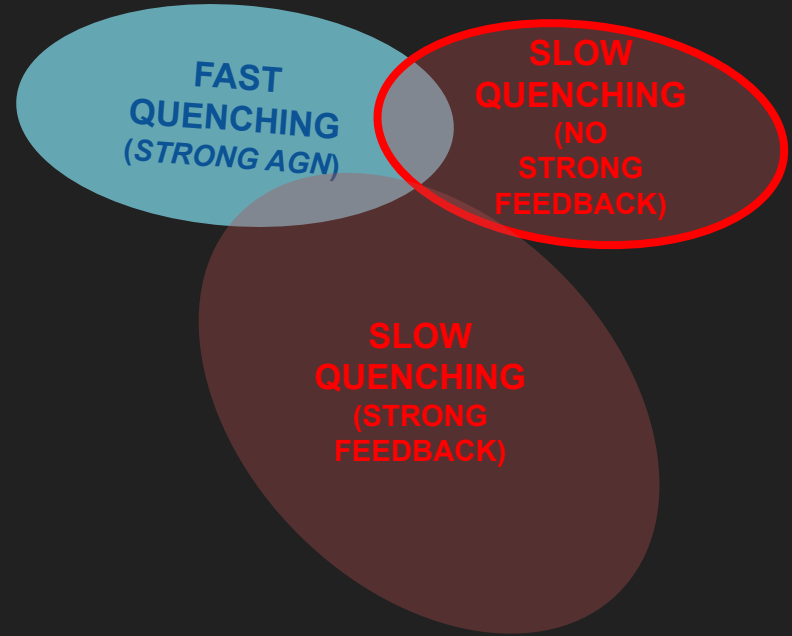
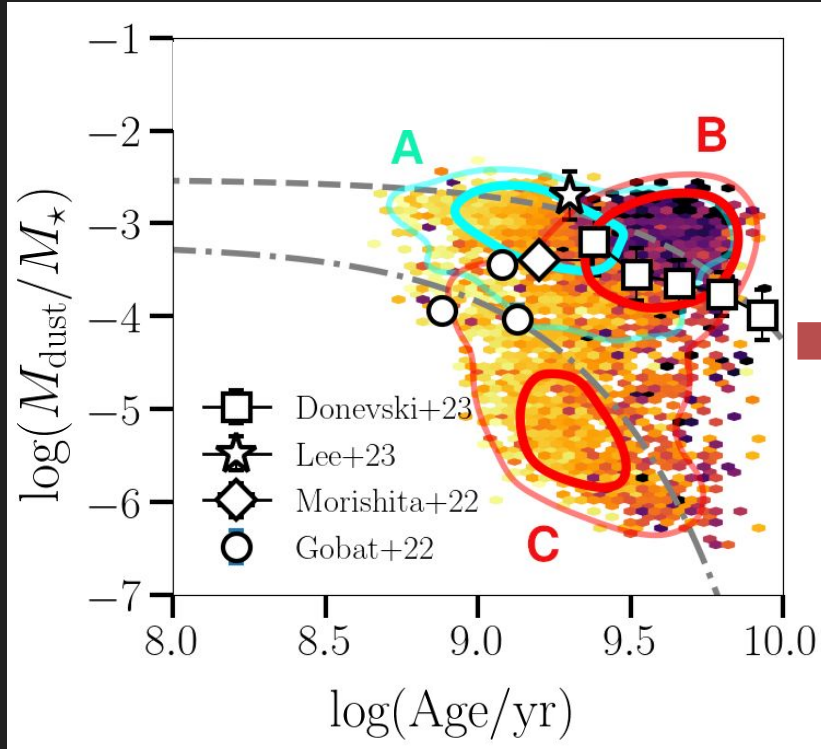
How did quench happened?



Lorenzon+25a



How did quench happened?



Lorenzon+25a

The hunt for dust with ALMA

The hunt for dust with ALMA

And the crazy competition to get data

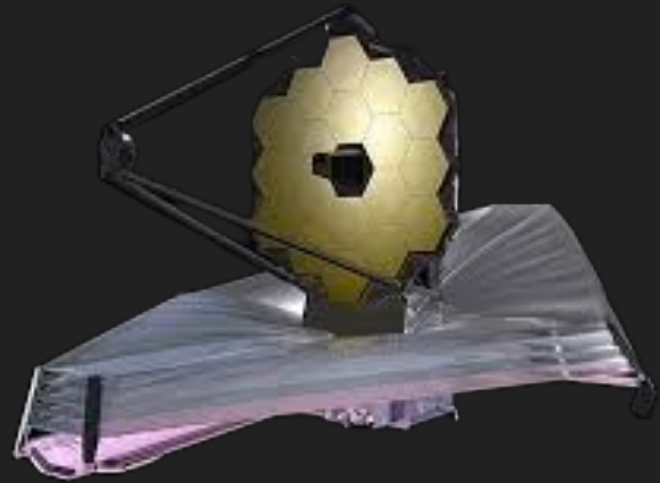
“Low” frequency synergy

ALMA



Sub-mm / radio

JWST



Near / Mid InfraRed

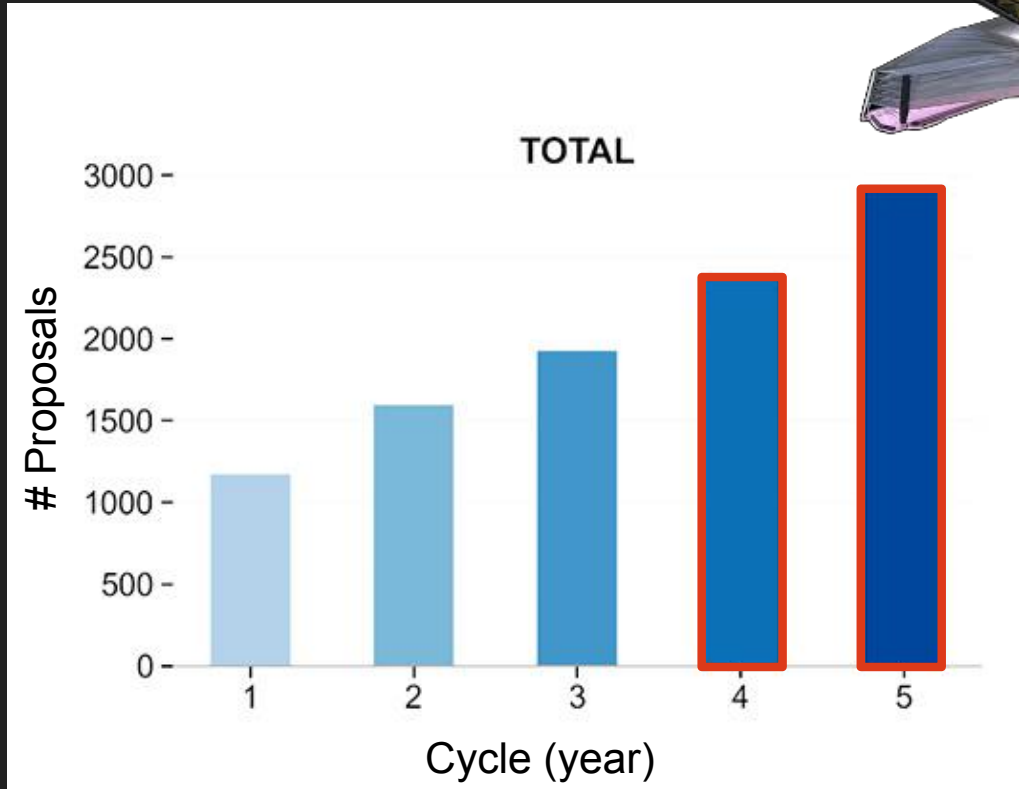
Huge competition for data



Cycle 11 Proposal Submission Statistics

	All	Chile	East Asia	Europe	North America	Other
12-m Array time (hours)	31,610	2346	6647	11,946	9752	919
Offered	4300	430	968	1451	1451	see note
Subscription	7.4	5.5	6.9	8.2	6.7	N/A

Huge competition for data



Allocated:
8000 hrs

Requested:
101,751 hrs

ALMA reveals diverse dust-to-gas mass ratios and quenching modes in old quiescent galaxies

G. LORENZON,¹ D. DONEVSKI,^{1,2} A. W. S. MAN,³ M. ROMANO,^{4,5} K. E. WHITAKER,⁶ S. BELLI,⁷ D. LIU,⁸ M. M. LEE,⁹
D. NARAYANAN,^{10,11} A. LONG,^{12,13} I. SHIVAEI,¹⁴ A. NANNI,^{1,15} K. LISIECKI,¹ P. SAWANT,¹ G. RODIGHIERO,¹⁶
I. DAMJANOV,¹⁷ JUNAIS,^{18,19} R. DAVÉ,^{20,21} C. PAPPALARDO,²² C. LOVELL,²³ AND M. HAMED¹⁴

¹National Center for Nuclear Research, Pasteura 7, 02-093 Warsaw, Poland

²SISSA, Via Bonomea 265, 34136 Trieste, Italy

³Department of Physics & Astronomy, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada

⁴Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121, Bonn, Germany

⁵INAF, OAPD, Vicolo dell'Osservatorio, 5, 35122 Padova, Italy

⁶Department of Astronomy, University of Massachusetts, Amherst, MA 01003, USA

⁷Dipartimento di Fisica e Astronomia, Università di Bologna, Bologna, Italy

⁸Purple Mountain Observatory, Nanjing, China

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¹⁴Centro de Astrobiología (CAB), CSIC-INTA, Carretera de Ajalvir km 4, Torrejón de Ardoz 28850, Madrid, Spain

¹⁵INAF - Osservatorio Astronomico d'Abruzzo, Via Maggini SNC, 64100, Teramo, Italy

¹⁶Dipartimento di Fisica e Astronomia, Università di Padova, Vicolo dell'Osservatorio, 3, I-35122 Padova, Italy

¹⁷Department of Astronomy and Physics, Saint Mary's University, 923 Robie Street, Halifax, NS, B3H 3C3, Canada

¹⁸Instituto de Astrofísica de Canarias, Vía Láctea S/N, E-38205 La Laguna, Spain

¹⁹Departamento de Astrofísica, Universidad de La Laguna, E-38206 La Laguna, Spain

²⁰Institute for Astronomy, Royal Observatory, University of Edinburgh, Edinburgh EH9 3HJ, UK

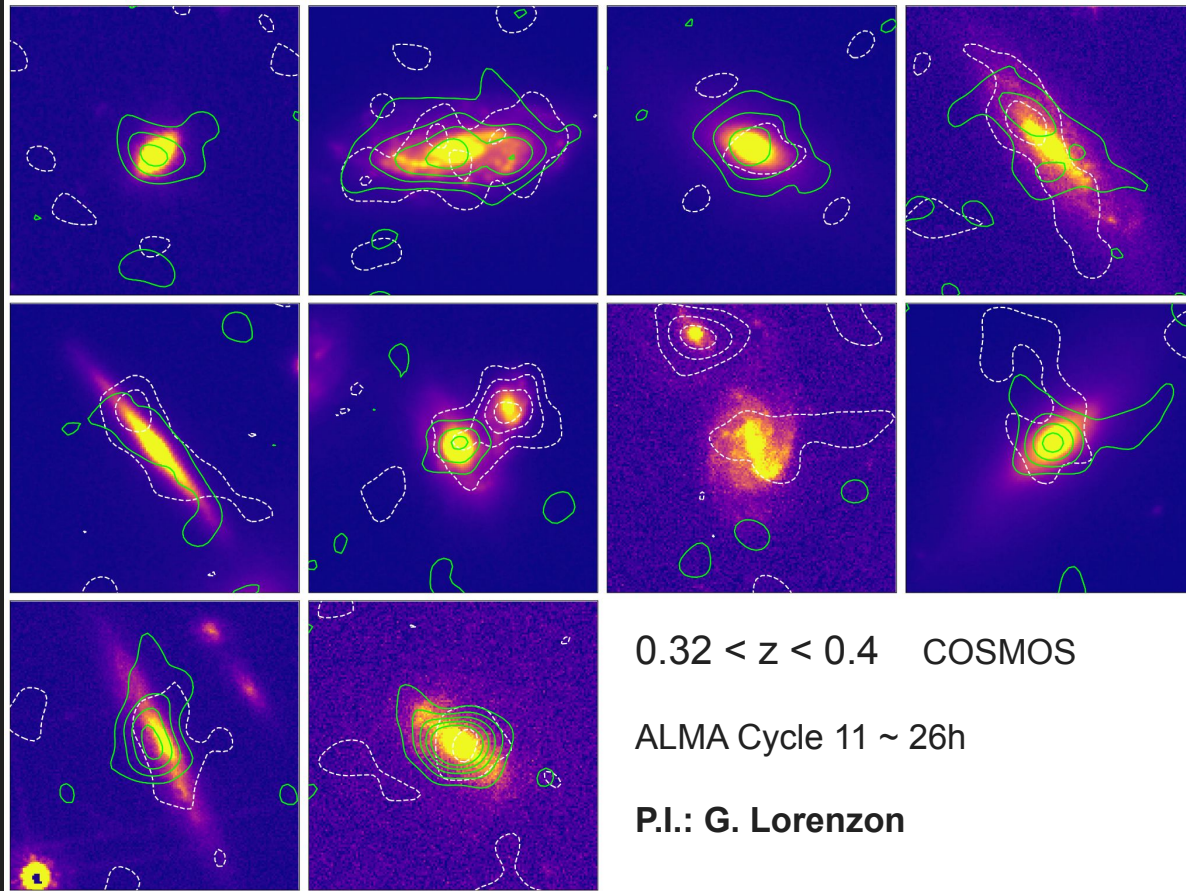
²¹Department of Physics & Astronomy, University of the Western Cape, Robert Sobukwe Rd, Bellville, 7535, South Africa

²²Instituto de Astrofísica e Ciências do Espaço, Universidade de Lisboa - OAL, Tapada da Ajuda, 1349-018, Lisboa, Portugal

²³Institute of Cosmology and Gravitation, University of Portsmouth, Burnaby Road, Portsmouth PO1 3FX, UK

Accepted for
publication in
ApJL

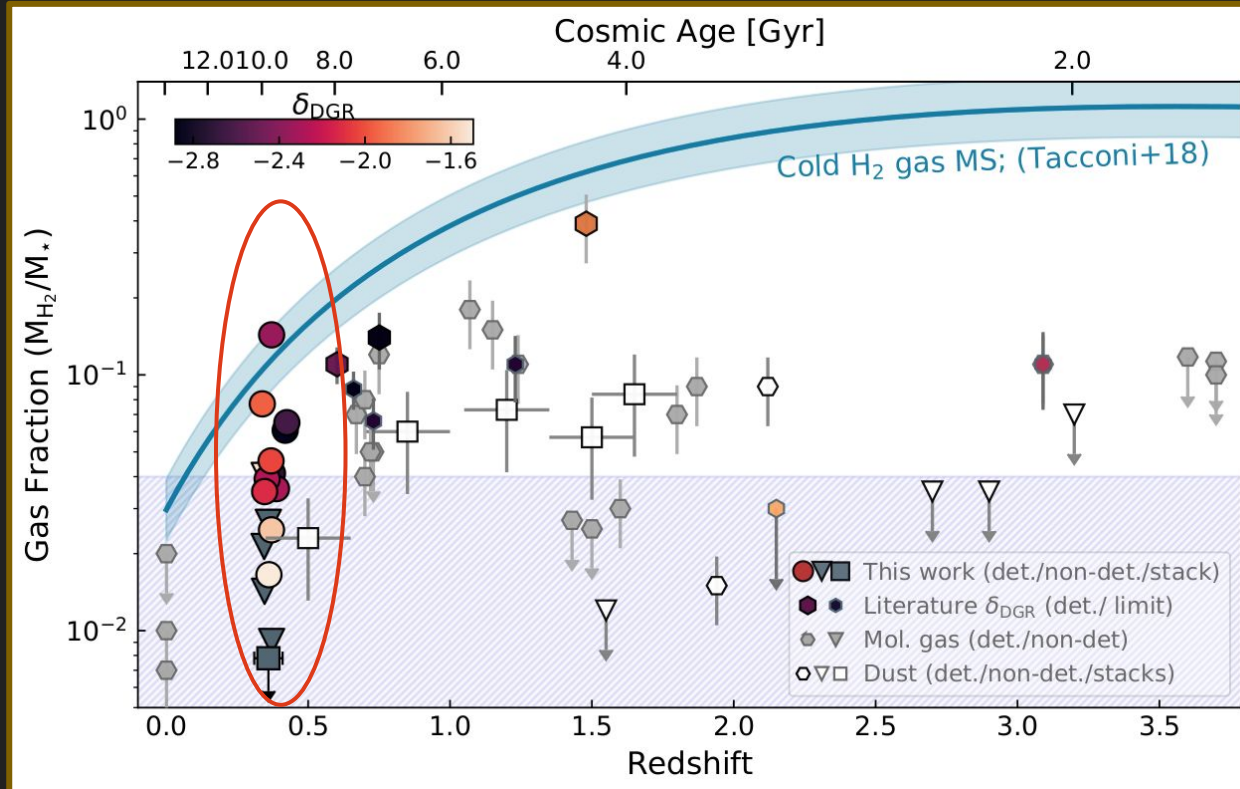
The ALMA observations results



**BOTH Gas and
Dust emission
detections**

**Allows first
constraints of DGR
in quiescent
sources**

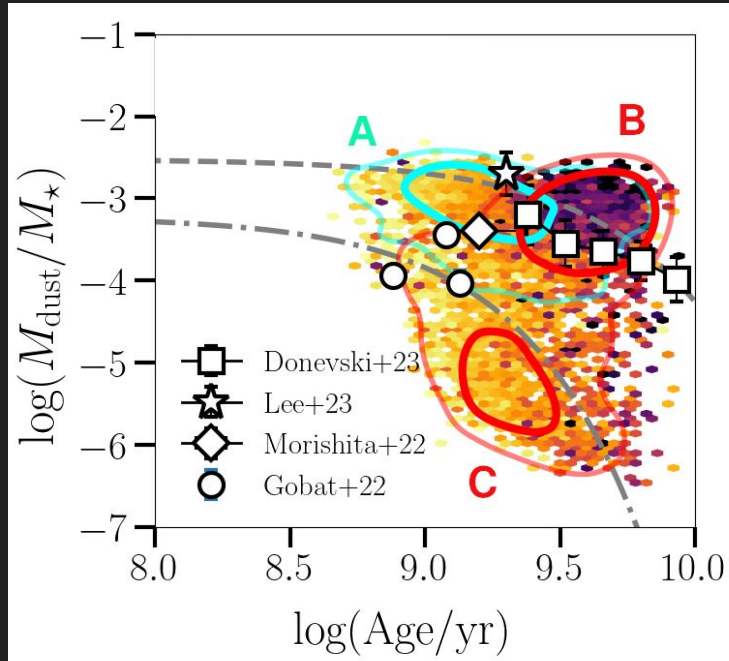
Extending the parameter space



Our is the first ever measurement of dust-to-gas ratio in multiple quiescent galaxies beyond the local universe

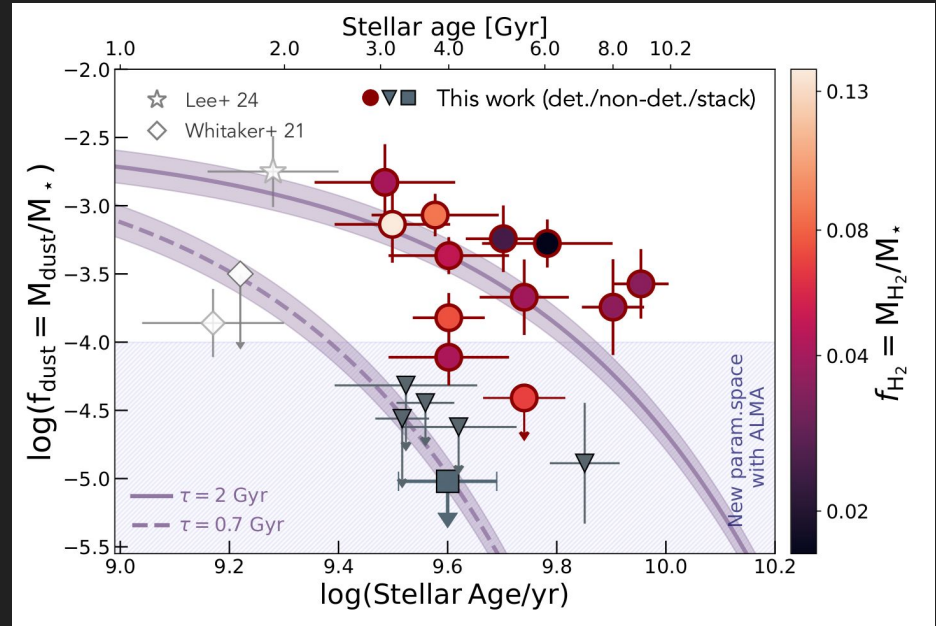
Do dust and gas evolves together?

Simulation



Lorenzon+25a

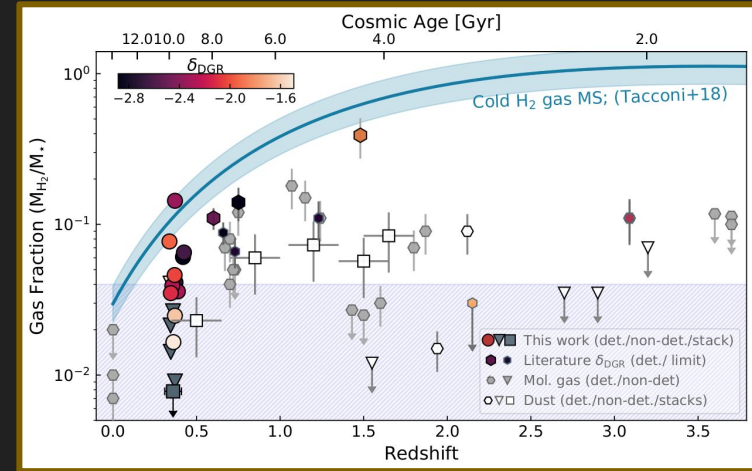
First observed sample



Lorenzon+25b - accepted

Summary

- Both simulations and observations tell us that ISM can still be present in QGs
- The dust-to-gas ratio is not confined in a narrow range for QGs!
- Dust and Gas might evolve through different channels after quiescence



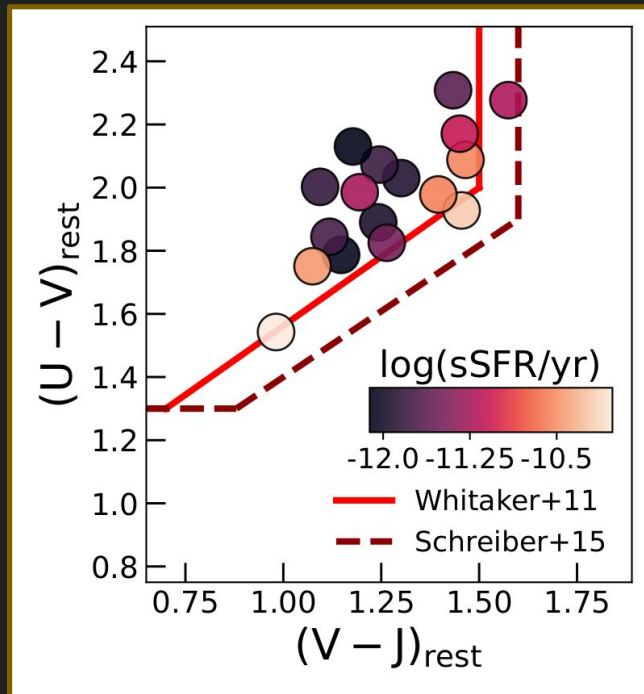
giuliano.lorenzoni@ncbj.gov.pl

giuliano.lorenzoni97@gmail.com

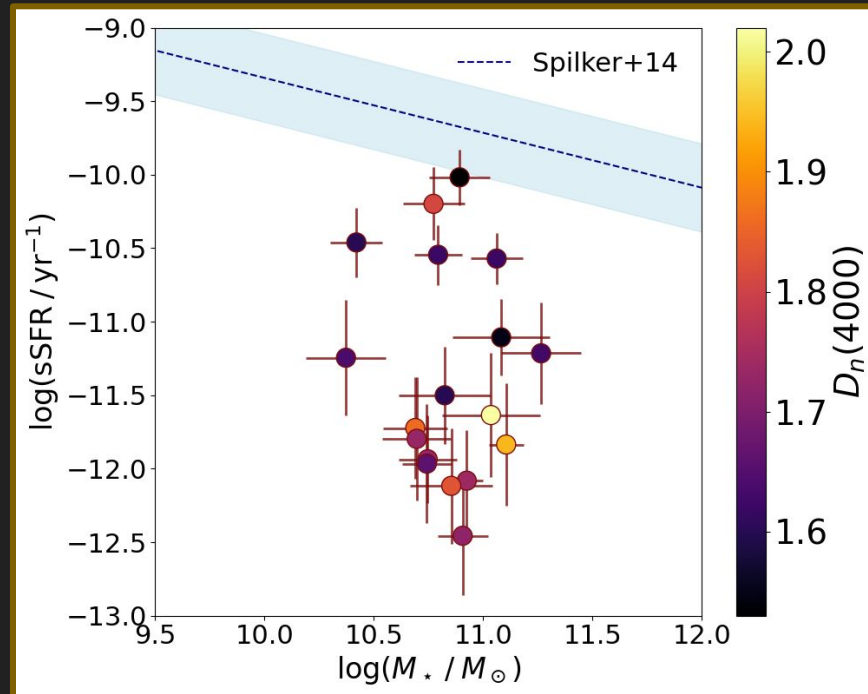
Grazie - Dziękuję - Danke - Thank you !

Backups

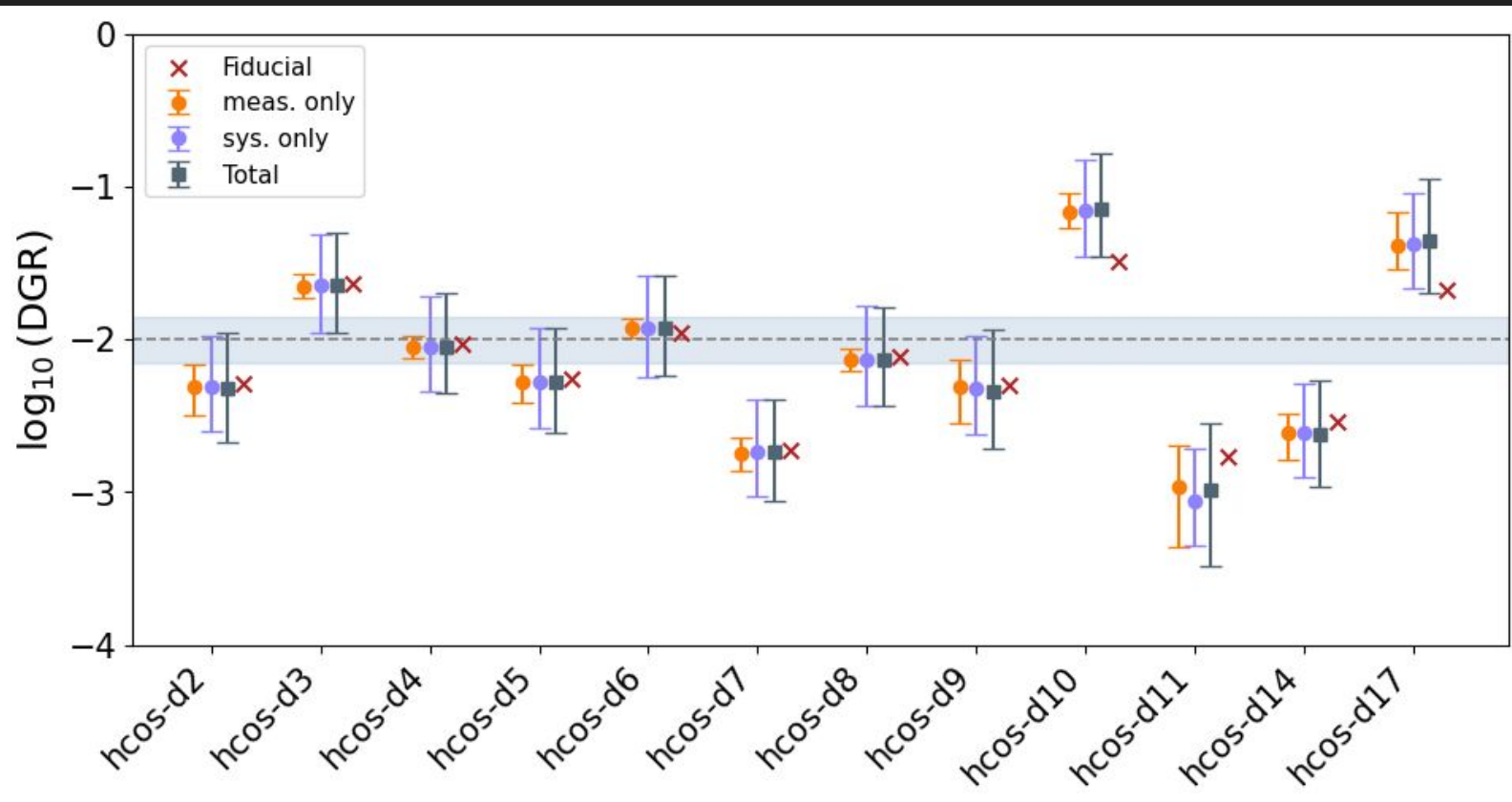
Sample properties / selection



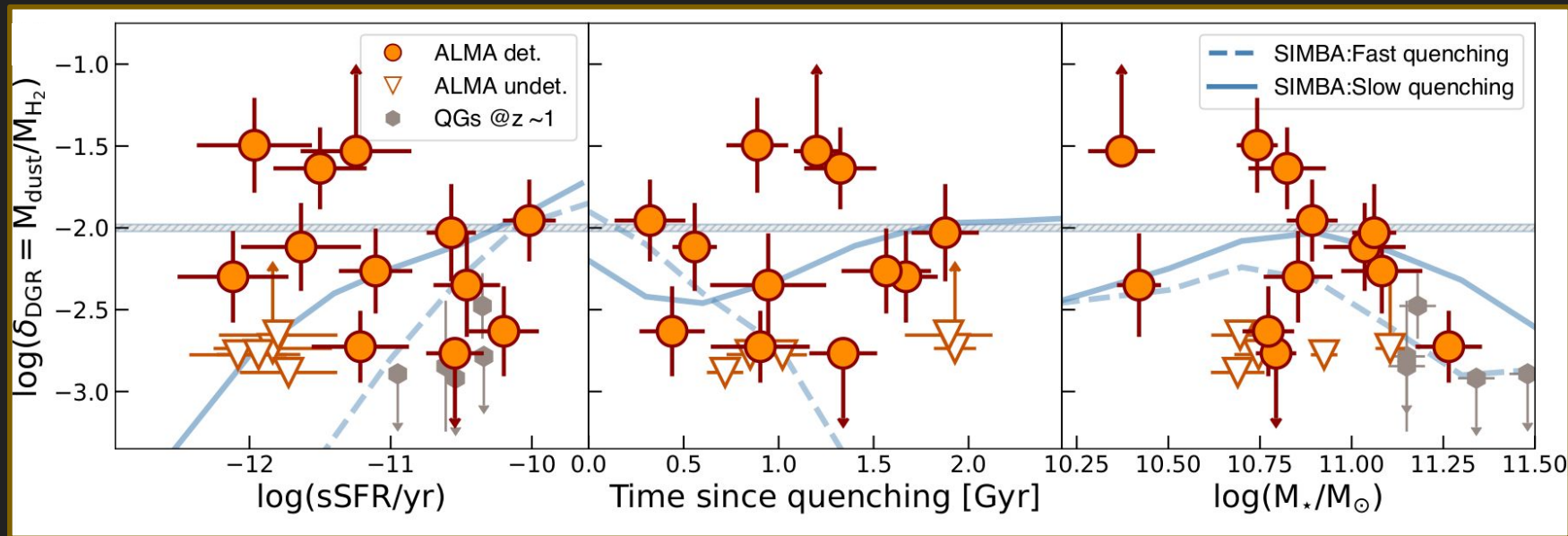
Lorenzon+25a - in review



Accounting for CO-to-H₂ conversion(s)



ISM and stellar properties



Lorenzon+25a - in review