

GIULIA PEROTTI

Postdoc fellow, MPIA

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EDUCATION

- 2021 Ph.D. ASTROPHYSICS & PLANETARY SCIENCE
Ice and Gas: Linking infrared and Millimetric observations towards young Solar-type Stars
Niels Bohr Institute (NBI), University of Copenhagen, Denmark
Supervisor: Prof. Jes K. Jørgensen
- 2017 M.Sc. PHYSICAL CHEMISTRY
Modelling the CO chemistry of star-forming regions
Departments of Chemistry and Physics, Niels Bohr Institute, University of Copenhagen, Denmark
Supervisors: Profs. Jes K. Jørgensen & Lars E. Kristensen

ACADEMIC EMPLOYMENTS

- 2021 - 2024 POSTDOCTORAL RESEARCH FELLOW
Planet and Star Formation (PSF) Fellowship, Max Planck Institute for Astronomy (MPIA), Heidelberg, Germany
Hosts: Profs. Henrik Beuther & Thomas Henning
- 2021 RESEARCH ASSISTANT at the Globe Institute, Copenhagen, Denmark, after Ph.D. submission

AWARDS AND GRANTS

- 2023 Ernst Patzer Award for the best publication by MPIA/ZAH junior scientists, 2000 EUR
- 2022 MPIA Bonuses for outstanding performance at MPIA, Heidelberg, Germany, 2200 EUR
- 2021 PSF Fellowship at MPIA, Heidelberg, Germany, 3 yr, >200k EUR
- 2018 COST ACTION: "Our Astro-Chemical History", Travel grants, 3000 EUR
- 2016 iGEM COMPETITION "Astrobiology" at Massachusetts Institute for Technology, Bronze medal

TELESCOPE TIME AWARDS

	As PI:	As co-I or team member:
2022	ALMA, 16.6 hrs, 2022.1.00727.S, A	JWST, 385.5 hrs, 8 programs (8 GO, 2 GTO, 1 ERS)
2021	APEX, 18 hrs, 0108.F-9304, A	ALMA, 49.7 hrs, 3 programs, C
2020	SMA, 10 hrs, 2020B-S023B-S014, A	GBT, 300+ hrs, large program, A
2020	APEX, 18 hrs, 0107.F-9304, A	IRAM30m, 108.4 hrs, 2 programs, A & B
2019	SMA, 10 hrs, 2019B-S014, B	GEMINI, 2.5 hrs, 1 program, A
2019	ALMA, 16.4 hrs, 2019.2.00087.S, C	IRTF, 7.5 hrs, 1 program, A
2019	APEX, 22 hrs, 0105.F-9300, A	
2018	APEX, 11 hrs, 0102.F-9304, A	
2018	SMA, 8 hrs, 2018A-S033, B	

MANAGEMENT EXPERIENCE

- 2022 - Management roles as part of the JWST-MINDS consortium
- 2022 Local organizing committee member of Heidelberg-Harvard meeting
- 2022 Local organizing committee member of Early Phase of Star Formation (EPoS)
- 2022 Organizer of the workshop "Introduction to ice spectroscopy fitting"
- 2021 - Member of MPIA Strategic Time Allocation Committee (STAC)

REVIEWING ACTIVITIES

- 2021 Reviewer for AAS journals (incl., ApJ, ApJL), A&A & Nature Astronomy

RESEARCH ACTIVITY AND ACHIEVEMENTS

Star and planet formation, astrochemistry, infrared and millimetric observations

I used a novel multi-wavelength approach to investigate the chemistry of young protostars (Ph.D.) and planet-forming disks (Postdoc) to simultaneously study gaseous and solid molecules (e.g., water and methanol). I have contributed to the development of the ENIGMA code, largely used to interpret JWST data. I worked on some of the very first JWST disk data and discovered, for the first time, a substantial water reservoir in the inner regions of a planet-hosting disk.

INTERNATIONAL COLLABORATIONS

Collaborations with researchers in several countries on three continents. I have several collaborations with researchers from my former/current affiliations and research visits: Copenhagen (Profs. Jørgensen, Andersen, Hassenkam), Heidelberg (Profs. Henning, Beuther), Leiden (Profs. van Dishoeck, McClure), USA (Profs. Pontoppidan, Öberg, Boogert).

I am also a member of 3 large JWST collaborations: 1 Early Release Science program, Ice Age (PI: McClure, 50+ members), 2 Guaranteed Time Observation programs, JOYS (PI: van Dishoeck, ~25 members), MINDS (PI: Henning, ~50 members).

TEACHING & MENTORING

- 2023/2024 Teaching at the M.Sc. course "Molecular Astrophysics"
University of Heidelberg, Germany, fall semester
- 2023/2024 Teaching/mentoring at the M.Sc. course "MVSem: Protostars and Planets"
University of Heidelberg, Germany, fall semester
- 2022/2023 Teaching at the M.Sc. course "Molecular Astrophysics"
University of Heidelberg, Germany, fall semester
- 2019/2020 Co-supervision of the B.Sc. thesis of Vera Matenaar
Niels Bohr Institute & London Metropolitan University, United Kingdom
- 2018 - 2021 Teaching Assistant at the Ungsdomslab (ULAB)
Niels Bohr Institute, University of Copenhagen, Denmark
- 2018 Teaching Assistant for the M.Sc. course "The ISM and the formation of stars"
Niels Bohr Institute, University of Copenhagen, Denmark, Block 4

MEMBERSHIP OF SCIENTIFIC SOCIETIES

- 2021 - Junior Member of the International Astronomical Union (IAU)
- 2020 - Member of the American Astronomical Society (AAS)
- 2020 - Member of the European Astronomical Society (EAS)

OUTREACH & SERVICE

- 2021 - 2023 Representative of the Postdocs at Max Planck Institute for Astronomy, Heidelberg, Germany
- 2023 Co-organizer of Tag der offenen Tür des MPIA, Spectroscopy stand, Heidelberg, Germany
- 2021 Organizer of the MPIA weekly seminar of the Planet and Star Formation department
- 2021 - Organizer of the [Königstuhl Colloquium](#), MPIA, LSW, ZAH weekly joint seminar
- 2021 - Organizer of [Astrochemistry Discussions](#), monthly webinar series and podcast
- 2021 - 2023 Scientific writer for [duegradi](#), magazine on climate change, 5 articles
- 2020 - 2021 Co-organizer of [Astronomy on Tap Copenhagen](#), monthly astronomy outreach event

FURTHER RESEARCH EXPERIENCE

- 2020 Visiting research group of Prof. Boogert, Institute for Astronomy Manoa, Hawaii, 1 month
- 2020 Observing astronomer at the Submillimeter Array, Mauna Kea, USA, 5 nights
- 2018 Visiting research group of Prof. Fraser, The Open University, United Kingdom, 1 month
- 2017 Synchrotron measurements of meteorites, Paul Scherrer Institute, Switzerland, 3 days
- 2015 Observing astronomer at the North Optical Telescope, La Palma, Spain, 4 nights

INVITED SEMINARS & REVIEWS

Selected invited talks, reviews since 2018 (> 25)

11. 2023	Patzer Colloquium, MPIA, ZAH, Heidelberg, Germany
11. 2023	Königstuhl Colloquium, MPIA, LSW, ZAH, Heidelberg, Germany
10. 2023	Niels Bohr Institute, GLOBE Institute, Copenhagen, Denmark
10. 2023	Center for Interstellar Catalysis (InterCat), Aarhus, Denmark [listen here]
09. 2023	National Congress of Protoplanetary Astrochemistry, Trieste, Italy - review
08. 2023	Origins 2023, IAU Astrobiology, ISSOL, Quito, Ecuador - review [declined]
07. 2023	SPF seminar, ESO Munich, Garching, Germany
04. 2023	RIKEN, Tokyo, Japan
04. 2023	NAOJ, Tokyo, Japan
03. 2023	Fachbeirat 2023, MPIA, Heidelberg, Germany
03. 2023	Science Day, MPIA, Heidelberg, Germany
02. 2023	Université Paris Saclay, IAS, Paris, France
12. 2022	First JWST result meeting, Baltimore, USA - online [listen here]
11. 2022	ASIAA, Taipei, Taiwan - online
09. 2022	Niels Bohr Gold Medal Symposium, Copenhagen, Denmark
02. 2022	TUNA talk, NRAO, Charlottesville, USA - online
02. 2022	MPE, Center for Astrochemical Studies (CAS), Garching, Germany - online
05. 2021	Carnegie EPL Astronomy Seminars, Washington DC, USA - online
11. 2020	Chalmers University of Technology, Gothenburg, Sweden - online
10. 2020	ESO Munich, Garching, Germany - online
10. 2020	ZUNA talk, NRAO, Charlottesville, USA - online
06. 2020	Astrochemical Frontiers: Quarantine Edition - online
01. 2020	AAS 235 meeting, Honolulu, USA
07. 2018	ASIAA TIARA "Origins of the Solar System", Taipei, Taiwan
06. 2018	MPIA PSF Coffee, Heidelberg, Germany
06. 2018	Institute for Theoretical Astrophysics (ITA), Heidelberg, Germany
04. 2018	The Open University - Milton Keynes, United Kingdom

SELECTED PRESS RELEASES

As first author:

08. 2023	Spiegel	<u>Aufnahmen des James-Webb-Teleskops: Gibt es anderes Leben im Weltall?</u>
07. 2023	Spiegel+	<u>Schon auf der Baby-Erde könnte es Wasser gegeben haben</u>
07. 2023	MPIA	<u>Water discovered in rocky planet-forming zone offers clues on habitability</u>
07. 2023	CNN	<u>Webb telescope spots water in a nearby planetary system</u>
07. 2023	NASA/ESA	<u>Webb Detects Water Vapor in Rocky Planet-Forming Zone</u>

Full list of upcoming seminars, podcasts and press releases can be accessed [here](#).

Number of published and submitted publications (as of 17 October 2023)

In total:

18 papers (6 submitted)

As first author:

5 papers**First author papers**

Perotti G., Christiaens V., Henning Th., Tabone B., Waters L. B. F. M., Kamp I., Olofsson G., Grant S. L., Gasman D., Bouwman J., Samland M., Franceschi R., van Dishoeck E. F. et al. Water in the terrestrial planet-forming zone of the PDS 70 disk. *Nature*, 620, 516 (2023)

Description: Discovery of water in the only disk with confirmed planets using JWST/MIRI. The detection represents the first inspection of the region where terrestrial planets form in a nascent solar system. I performed the JWST data reduction/analysis, wrote the manuscript and I significantly contributed to the development of the data reduction pipeline. The mass media provided extensive coverage to the publication (e.g. NASA/ESA, CNN). The [press releases](#) led to multiple academic invitations, including (so far) 7 seminars, 1 review talk, several interviews, and 3 podcasts.

Perotti G., Jørgensen, J. K., Kristensen, L. E., Rocha W. R. M., Artur de la Villarmois E., Fraser, H. J., Bjerkele P., Sewilo M., and Charnley S. B. Linking in the Coronet Cluster in Corona Australis. *A&A*, 678, A78 (2023)

Description: Determination of the gas-ice interplay in Corona Australis. By using a set of observing facilities (SMA, APEX, VLT, Spitzer) we find that the methanol gas-to-ice ratios estimated in Corona Australis, Orion and Serpens are remarkably similar suggesting that the overall methanol chemistry is set during the prestellar stage. I am the PI of the SMA and APEX data. I performed the data reduction, lead the analysis/discussion and wrote all the manuscript.

Perotti G., Sørensen O. H., Haack H., Andersen C. A., Ferreira Sanchez D., van Kooten E. M. M. E., Tsai E. H. R., Dalby K. N., Holler M., Grolimund D., and Hassenkam T. Thermal history of matrix forsterite grains from Murchison based on high-resolution tomography. *ApJ*, 922, 256 (2021)

Description: First application of ptychographic X-ray nanotomography in planetary science. We characterise the 3D structure of building blocks of planets (Murchison samples) at nm resolution. I conducted this project during my Ph.D., *without co-authorship/guidance from my advisor*, showcasing my skill in bridging knowledge gaps to achieve holistic insights. I supported the sample preparation at the synchrotron, I lead the data analysis and wrote the manuscript.

Perotti G., Jørgensen, J. K., Fraser H. J., Suutarinen A. N., Kristensen L. E., Rocha W. R. M., Bjerkele P., and Pontoppidan K. M. Linking ice and gas in the λ Orionis Barnard 35A cloud. *A&A*, 650, A168 (2021)

Description: Determination of the gas-ice interplay in Orion. By observing the λ Orionis cluster with SMA, APEX, IRAM30m, AKARI we find a gas-ice opposite trend. This is explained by the physical conditions of the region: the gas emission is more intense and the ice abundances are lower towards the shocked region affected by ice sputtering. I am the PI of the SMA and APEX data. I performed the data reduction, lead the analysis and wrote all the manuscript.

Perotti G., Rocha W. R. M., Jørgensen, J. K., Kristensen, L. E., Fraser, H. J., and Pontoppidan K. M. Linking ice and gas in the Serpens low-mass star-forming region. *A&A*, 643, A48 (2020)

Description: Determination of the gas-ice interplay in Serpens. Using a multi-wavelength approach (SMA, APEX, VLT) we find that there is no straightforward correlation between the gas species with their solid-state counterparts in Serpens. I performed the data reduction, I merged the interferometric and single-dish data, I lead the analysis and wrote all the manuscript. **This project establishes the foundation for interpreting JWST gas and ice data.**

Non first-author papers with substantial contributions

Rocha W. R. M., **Perotti G.**, Kristensen, L. E., and Jørgensen, J. K. Fitting infrared ice spectra with genetic modelling algorithms. Presenting the ENIIGMA fitting tool. *A&A*, 654, A158 (2021)

Description: Presentation of ENIIGMA, a new toolbox for JWST data analysis. ENIIGMA is a publicly available code developed for the astrochemistry community. Since the release of JWST spectra on June 2022, ENIIGMA has been beneficial to the whole community. The novelty consists of identifying molecules using genetic modelling algorithms. I co-developed the tool, conducted the testing, wrote part of the manuscript and documentation.

He J., **Perotti G.**, Emtiaz, S. M., Toriello, F. E., Boogert, A. C. A., Henning, T., and Vidali, G. Ammonia in water-dominated ice mixtures explains the non-detection of the 2152 cm⁻¹ band. *ApJ*, 688, A76 (2022)

Description: Laboratory study on the non-detection of the 2152 cm⁻¹ band in protostellar spectra. Our results show that ammonia reduces the 2152 cm⁻¹ band more effectively than carbon dioxide. We propose for the first time in the literature that this is due to the polarity of ammonia when reacting with water. I lead the discussion, wrote all the manuscript except for the results section, and compared the lab data to infrared observations.

McClure M., Rocha, W. R. M., ..., **Perotti, G.** et al. An Ice Age JWST inventory of dense molecular cloud ices. *Nat. Astron.*, 7, 431 (2023)

Description: First results of the JWST Early Release Science program Ice Age. Weak ice features and complex organic molecules are detected for the first time along two pre-stellar lines of sight. Our results suggest that the formation of these species begins earlier than previously thought in a water-ice-rich environment. I reduced the spectra, fitted and analysed the cyanate ion band, and I wrote part of the manuscript.

Papers as part of JWST international collaborations

I am a member of **three JWST large international collaborations**: two Guaranteed Time Observation programs (MINDS and JOYS) - and one Early Release Science program (Ice Age). Since the JWST data I worked on were some of the very first disk observations to be carried out by JWST, I coordinated the development of a completely new data reduction pipeline that became essential for works that followed within the aforementioned collaborations and beyond. As part of the MINDS team, I covered leading roles such as chairing biweekly meetings, mentoring junior colleagues, sharing expertise, codes and data reduction tools as well as co-authoring the papers below. I wrote sections of the manuscripts and gave feedback to the first authors.

MINDS (MIRI mid-INfrared Disk Survey)

Gasman D., van Dishoeck E. F., Grant S., ..., **Perotti G.** et al. MINDS. Abundant water and varying C/O across the disk of Sz 98 as seen by JWST/MIRI. Accepted for publication in *A&A* (2023) (44 authors)

Kamp, I., Henning Th., Arabhavi A. M., ..., **Perotti G.** et al. The chemical inventory of the inner regions of planet-forming disks - the JWST/MINDS program, *Faraday Discuss.*, 245, 112 (2023) (43 authors)

Tabone B., Bettoni G., van Dishoeck E. F., ..., **Perotti G.** et al. A high rich hydrocarbon chemistry and a high C to O ratio in the inner disk around a very low-mass star. *Nat. Astron.*, 7, 805 (2023) (44 authors)

Grant S., van Dishoeck, E. F., Tabone, B., ..., **Perotti G.**, et al. MINDS. The Detection of $^{13}\text{CO}_2$ with JWST-MIRI Indicates Abundant CO_2 in a Protoplanetary Disk. *ApJL*, 947, L6 (2023) (46 authors)

JOYS (JWST Observations of Young protoStars)

Gieser C., Beuther H., van Dishoeck E. F., ..., **Perotti G.** et al. JOYS: Disentangling the warm and cold material in the high-mass IRAS 23385+6053 cluster. Accepted for publication in *A&A* (2023) (23 authors)

Ray, T., McCaughrean, M.J., Caratti o Garatti, A., ..., **Perotti G.** et al. Outflows from the Youngest Stars are Mostly Molecular. *Nature*, 622, 48 (2023) (23 authors)

Beuther, H., van Dishoeck, E. F., Tychoniec, L., ..., **Perotti, G.** et al. JOYS. JWST Observations of Young protoStars: Outflows and accretion in the high-mass star-forming region IRAS23385+6053. *A&AL*, 673, A121 (2023) (24 authors)

Ice Age

Sturm J. A., McClure M. K., Tracy B., ..., **Perotti G.** et al. A JWST inventory of protoplanetary disk ices: The edge-on protoplanetary disk HH 48 NE, seen with the Ice Age ERS program. Accepted for publication in *A&A* (2023) (27 authors)