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From clouds to comets: tracing the molecular journey of interstellar ices in the JWST era

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Publications

Refereed publications as first author

1. *Laboratory infrared spectra and band strengths of carbonyl sulfide (OCS) in CH₃OH- and CO-rich ice mixtures for analyzing interstellar ice observations*
K. Slavicinska, C. Coone, B. Benz, H. Linnartz, A. C. A. Boogert, K. -J. Chuang. *ACS Earth & Space Chemistry*, 2025, 9(8), 2148-2158
2. *HDO ice detected toward an isolated low-mass protostar with JWST*
K. Slavicinska, Ł. Tychoniec, M. G. Navarro, E. F. van Dishoeck, J. J. Tobin, M. L. van Gelder, Y. Chen, A. C. A. Boogert, W. B. Dreschsler, H. Beuther, A. Caratti o Garatti, S. T. Megeath, P. Klaassen, L. W. Looney, P. J. Kavanagh, N. G. C. Brunken, P. Sheehan, W. J. Fischer. *The Astrophysical Journal Letters*, 2025, 986(2), L19
3. *Ammonium hydrosulfide (NH₄SH) as a potentially significant sulfur sink in interstellar ices*
K. Slavicinska, A. C. A. Boogert, Ł. Tychoniec, E. F. van Dishoeck, M. L. van Gelder, M. G. Navarro, J. C. Santos, P. D. Klaassen, P. J. Kavanagh, K. -J. Chuang. *Astronomy & Astrophysics*, 2025, 693, A146
4. *JWST detections of amorphous and crystalline HDO ice toward massive protostars*
K. Slavicinska, E. F. van Dishoeck, Ł. Tychoniec, P. Nazari, A. E. Rubinstein, R. Gutermuth, H. Tyagi, Y. Chen, N. G. C. Brunken, W. R. M. Rocha, P. Manoj, M. Narang, S. T. Megeath, Y. -L. Yang, L. W. Looney, J. J. Tobin, H. Beuther, T. L. Bourke, H. Linnartz, S. Federman, D. M. Watson, H. Linz. *Astronomy & Astrophysics*, 2024, 688, A29
5. *The hunt for formamide in interstellar ices: A toolkit of laboratory infrared spectra in astronomically relevant ice mixtures and comparisons to ISO, Spitzer, and JWST observations*
K. Slavicinska, M. G. Rachid, W. R. M. Rocha, K. -J. Chuang, E. F. van Dishoeck, H. Linnartz. *Astronomy & Astrophysics*, 2023, 677, A13
6. *Link between polycyclic aromatic hydrocarbon size and aqueous alteration in carbonaceous chondrites revealed by laser mass spectrometry*
K. Slavicinska, D. Duca, D. Egorov, T. Mitra, Y. Carpentier, C. Focsa, C. J. Bennett, C. Pirim. *ACS Earth & Space Chemistry*, 2022, 6(6), 1413-1428

Refereed publications as co-author

1. *JOYS: Launching and destruction of dust in protostellar jets. The case of BHR71-IRS1 with JWST/MIRI*
Ł. Tychoniec, L. Francis, M. G. Navarro, J. M. Vorster, E. F. van Dishoeck, K. Assani, V. J. M. Le Gouellec, B. Tabone, P. Klaassen, A. G. M. Janssen, K. Justtanont, D. Harsono, P. Nazari, S. Reyes, **K. Slavicinska**, C. Gieser, T. Bourke, Y. -L. Yang, B.

- Nisini, T. Giannini, H. Beuther, R. Devaraj, T. P. Ray, N. G. C. Brunken, Y. Chen, M. L. van Gelder. *Astronomy & Astrophysics*, 2026, in press
2. *JOYS: Linking the molecular ice and gas phase composition toward the high-mass hot core IRAS 18089-1732*
C. Gieser, W. R. M. Rocha, Y. Chen, **K. Slavicinska**, E. F. van Dishoeck, P. Nazari, N. G. C. Brunken, L. Francis, H. Beuther, S. Reyes, A. Caratti o Garatti, P. D. Klaassen, J. M. Vorster, M. G. Navarro. *Astronomy & Astrophysics*, 2026, in press
3. *Investigating the nested structure of the outflow from the low luminosity protostar IRAS 16253-2429 using JWST and ALMA*
M. Narang, H. Tyagi, N. Ohashi, P. Manoj, S. T. Megeath, J. J. Tobin, E. F. van Dishoeck, N. J. Evans, D. M. Watson, A. Caratti o Garatti, J. K. Jørgensen, R. Gutermuth, Y. Aso, H. Beuther, L. W. Looney, D. A. Neufeld, G. Anglada, M. Osorio, A. E. Rubinstein, S. Federman, L. W. Hartmann, P. Nazari, N. Karnath, H. Linz, T. Stanke, T. L. Bourke, Y. -L. Yang, R. Kuiper, J. Green, P. Klaassen, W. Zakri, N. Habel, N. G. C. Brunken, J. Muzerolle, **K. Slavicinska**, A. M. Stutz, Ł. Tychoniec, S. Wolk, W. R. M. Rocha, W. J. Fischer. *The Astrophysical Journal*, 2026, 1000(2), 184
4. *IPA: Accretion rate of a low-mass class 0 protostar, measured via mid-IR fluorescent OH emission*
D. M. Watson, M. Narang, C. V. Pittman, H. Tyagi, R. Gutermuth, A. E. Rubinstein, N. J. Evans, L. W. Hartmann, S. T. Megeath, P. Manoj, C. C. Espaillat, N. Calvet, A. Caratti o Garatti, E. F. van Dishoeck, T. L. Bourke, J. D. Green, C. M. Lisse, P. Klaassen, L. W. Looney, P. Nazari, D. A. Neufeld, J. J. Tobin, S. J. Wolk, G. Anglada, P. Atnagulov, H. Beuther, N. G. C. Brunken, S. Federman, E. Furlan, N. Habel, N. Karnath, H. Linz, J. Muzerolle Page, M. Osorio, R. Pokhrel, R. Rahatgaonkar, W. R. M. Rocha, P. D. Sheehan, **K. Slavicinska**, T. Stanke, A. M. Stutz, Ł. Tychoniec, Y. -L. Yang, W. J. Fischer. *The Astrophysical Journal*, 2026, 999(2), 264
5. *JWST observations of segregated $^{12}\text{CO}_2$ and $^{13}\text{CO}_2$ ices in protostellar envelopes*
N. G. C. Brunken, A. C. A. Boogert, E. F. van Dishoeck, N. J. Evans, C. A. Poteet, **K. Slavicinska**, Ł. Tychoniec, P. Nazari, L. W. Looney, H. Tyagi, M. Narang, P. Klaassen, Y. -L. Yang, P. J. Kavanagh, S. T. Megeath, M. E. Ressler. *ACS Earth & Space Chemistry*, 2025, 9(8), 1992-2003
6. *JWST Observations of Young protoStars (JOYS): Overview of program and early results*
E. F. van Dishoeck, W. R. M. Rocha, **K. Slavicinska**, L. Francis, M. L. van Gelder, T. P. Ray, H. Beuther, A. Caratti o Garatti, N. G. C. Brunken, Y. Chen, R. Devaraj, V. C. Geers, C. Gieser, T. P. Greene, K. Justtanont, V. J. M. Le Gouellec, P. J. Kavanagh, P. D. Klaassen, A. G. M. Janssen, M. G. Navarro, P. Nazari, S. Notsu, G. Perotti, M. E. Ressler, S. D. Reyes, A. D. Sellek, B. Tabone, C. Tap, N. C. M. A. Theijssen, L. Colina, M. Güdel, Th. Henning, P. -O. Lagage, G. Östlin, B. Vandenbussche, G. S. Wright. *Astronomy & Astrophysics*, 2025, 699, A361
7. *JWST-IPA: Chemical inventory and spatial mapping of ices in the protostar HOPS 370 – Evidence for an opacity hole and thermal processing of ices*
H. Tyagi, P. Manoj, M. Narang, S. T. Megeath, W. R. M. Rocha, N. G. C. Brunken, A. E.

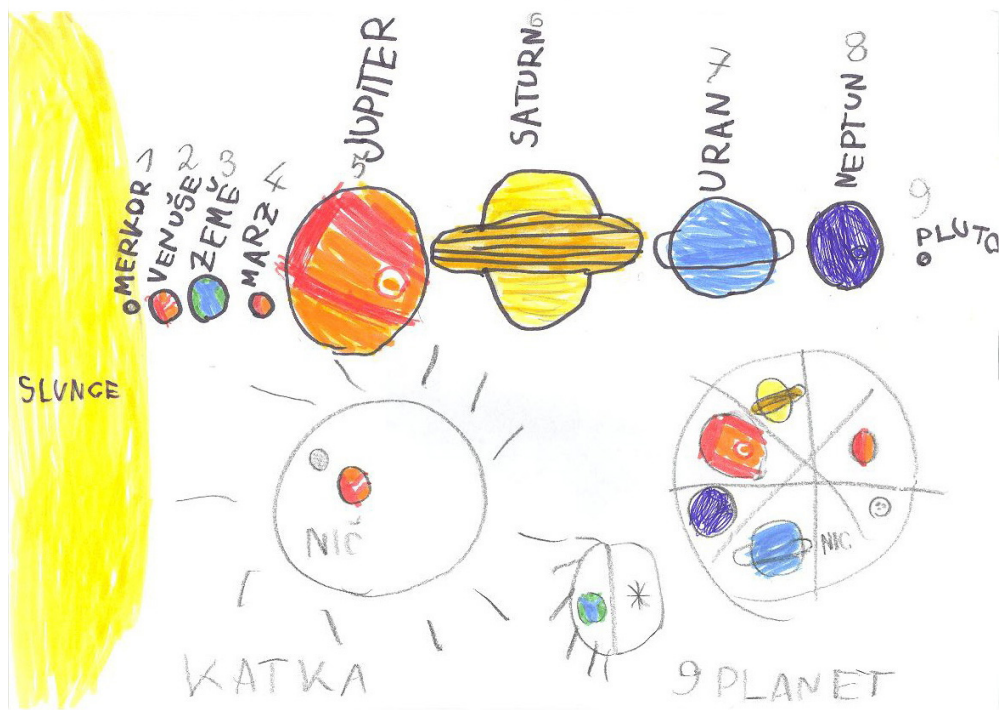
- Rubinstein, R. Gutermuth, N. J. Evans, E. F. van Dishoeck, S. Federman, D. M. Watson, D. A. Neufeld, G. Anglada, H. Beuther, A. Caratti o Garatti, L. W. Looney, P. Nazari, M. Osorio, T. Stanke, Y. -L. Yang, T. L. Bourke, W. J. Fischer, E. Furlan, J. Green, N. Habel, P. Klaassen, N. Karnath, H. Linz, J. Muzerolle, J. J. Tobin, P. Atnagulov, R. Rahatgaonkar, P. Sheehan, **K. Slavicinska**, A. M. Stutz, Ł. Tychoniec, S. Wolk, W. Zakri. *The Astrophysical Journal*, 2025, 983, 110
8. *JWST Observations of Young protoStars (JOYS): Overview of gaseous molecular emission and absorption in low-mass protostars*
M. L. van Gelder, L. Francis, E. F. van Dishoeck, T. P. Ray, H. Beuther, A. Caratti o Garatti, Y. Chen, R. Devaraj, C. Gieser, K. Justtanont, P. J. Kavanagh, P. Nazari, S. Reyes, W. R. M. Rocha, **K. Slavicinska**, M. Güdel, Th. Henning, P. -O. Lagage, G. Wright. *Astronomy & Astrophysics*, 2024, 692, A197
 9. *JOYS+ study of solid-state $^{12}\text{C}/^{13}\text{C}$ isotope ratios in protostellar envelopes: Observations of CO and CO₂ ice with the James Webb Space Telescope*
N. G. C. Brunken, E. F. van Dishoeck, **K. Slavicinska**, V. J. M. le Gouellec, W. R. M. Rocha, L. Francis, Ł. Tychoniec, M. L. van Gelder, M. G. Navarro, A. C. A. Boogert, P. J. Kavanagh, P. Nazari, T. Greene, M. E. Ressler, L. Majumdar. *Astronomy & Astrophysics*, 2024, 692, A163
 10. *JOYS+: link between ice and gas of complex organic molecules: Comparing JWST and ALMA data of two low-mass protostars*
Y. Chen, W. R. M. Rocha, E. F. van Dishoeck, M. L. van Gelder, P. Nazari, **K. Slavicinska**, L. Francis, B. Tabone, M. E. Ressler, P. D. Klaassen, H. Beuther, A. C. A. Boogert, C. Gieser, P. J. Kavanagh, G. Perotti, V. J. M. Le Gouellec, L. Majumdar, M. Güdel, Th. Henning. *Astronomy & Astrophysics*, 2024, 690, A205
 11. *JOYS: Linked accretion and ejection in a Class I protobinary system*
Ł. Tychoniec, M. L. van Gelder, E. F. van Dishoeck, L. Francis, W. R. M. Rocha, A. Caratti o Garatti, H. Beuther, C. Gieser, K. Justtanont, H. Linnartz, V. J. M. Le Gouellec, G. Perotti, R. Devaraj, B. Tabone, T. P. Ray, N. G. C. Brunken, Y. Chen, P. J. Kavanagh, P. Klaassen, **K. Slavicinska**, M. Güdel, G. Östlin. *Astronomy & Astrophysics*, 2024, 687, A36
 12. *Hunting for complex cyanides in protostellar ices with the JWST: A tentative detection of CH₃CN and C₂H₅CN*
P. Nazari, W. R. M. Rocha, A. E. Rubinstein, **K. Slavicinska**, M. G. Rachid, E. F. Van Dishoeck, S. T. Megeath, R. Gutermuth, H. Tyagi, N. G. C. Brunken, M. Narang, P. Manoj, D. M. Watson, N. J. Evans, S. Federman, J. Muzerolle Page, G. Anglada, H. Beuther, P. Klaassen, L. W. Looney, M. Osorio, T. Stanke, Y. -L. Yang. *Astronomy & Astrophysics*, 2024, 686, A71
 13. *JWST observations of $^{13}\text{CO}_2$ ice: Tracing the chemical environment and thermal history of ices in protostellar envelopes*
N. G. C. Brunken, W. R. M. Rocha, E. F. Van Dishoeck, R. Gutermuth, H. Tyagi, **K. Slavicinska**, P. Nazari, S. T. Megeath, N. J. Evans II, M. Narang, P. Manoj, A. E. Rubinstein, D. M. Watson, L. W. Looney, H. Linnartz, A. Caratti o Garatti, H. Beuther,

- H. Linz, P. Klaassen, C. A. Poteet, S. Federman, G. Anglada, P. Atnagulov, T. L. Bourke, W. J. Fischer, E. Furlan, J. Green, N. Habel, L. Hartmann, N. Karnath, M. Osorio, J. Muzerolle Page, R. Pokhrel, R. Rahatgaonkar, P. Sheehan, T. Stanke, A. M. Stutz, J. J. Tobin, Ł. Tychoniec, S. Wolk, Y. -L. Yang. *Astronomy & Astrophysics*, 2024, 685, A27
14. *JOYS: Detecting icy complex organic molecules and ions - I. CH₄, SO₂, HCOO⁻, OCN⁻, H₂CO, HCOOH, CH₃CH₂OH, CH₃CHO, CH₃OCHO, and CH₃COOH*
W. R. M. Rocha, E. F. Van Dishoeck, M. E. Ressler, M. L. Van Gelder, **K. Slavicinska**, N. G. C. Brunken, H. Linnartz, T. P. Ray, H. Beuther, A. Caratti o Garatti, V. Geers, P. J. Kavanagh, P. D. Klaassen, K. Justtanont, Y. Chen, L. Francis, C. Gieser, G. Perotti, M. Barsony, L. Majumdar, V. J. M. Le Gouellec, L. E. U. Chu, B. W. P. Lew, Th. Henning, G. Wright. *Astronomy & Astrophysics*, 2024, 683, A124
 15. *JOYS: MIRI/MRS spectroscopy of gas-phase molecules from the high-mass star-forming region IRAS 23385+6053*
L. Francis, M. L. van Gelder, E. F. van Dishoeck, C. Gieser, H. Beuther, Ł. Tychoniec, G. Perotti, A. Caratti o Garatti, P. J. Kavanagh, T. Ray, P. Klaassen, K. Justtanont, H. Linnartz, W. R. M. Rocha, **K. Slavicinska**, M. Güdel, Th. Henning, P. -O. Lagage, G. Östlin. *Astronomy & Astrophysics*, 2024, 683, A249
 16. *IPA. Class 0 protostars viewed in CO emission using JWST/NIRSpec*
A. E. Rubinstein, N. J. Evans, H. Tyagi, M. Narang, P. Nazari, R. Gutermuth, S. Federman, P. Manoj, J. D. Green, D. M. Watson, S. T. Megeath, W. R. M. Rocha, N. G. C. Brunken, **K. Slavicinska**, E. F. van Dishoeck, H. Beuther, T. L. Bourke, A. Caratti o Garatti, L. Hartmann, P. Klaassen, H. Linz, L. W. Looney, J. Muzerolle, T. Stanke, J. J. Tobin, S. J. Wolk, Y. -L. Yang. *The Astrophysical Journal*, 2024, 974, 112
 17. *Discovery of a collimated jet from the low-luminosity protostar IRAS 16253-2429 in a quiescent accretion phase with the JWST*
M. Narang, P. Manoj, H. Tyagi, D. M. Watson, S. T. Megeath, S. Federman, A. E. Rubinstein, R. Gutermuth, A. Caratti o Garatti, H. Beuther, T. L. Bourke, E. F. van Dishoeck, N. J. Evans, G. Anglada, M. Osorio, T. Stanke, J. Muzerolle, L. W. Looney, Y. -L. Yang, P. Klaassen, N. Karnath, P. Atnagulov, N. G. C. Brunken, W. J. Fischer, E. Furlan, J. Green, N. Habel, L. Hartmann, H. Linz, P. Nazari, R. Pokhrel, R. Rahatgaonkar, W. R. M. Rocha, P. Sheehan, **K. Slavicinska**, A. M. Stutz, J. J. Tobin, Ł. Tychoniec, S. Wolk. *The Astrophysical Journal Letters*, 2024, 962, L16
 18. *Investigating protostellar accretion-driven outflows across the mass spectrum: JWST NIRSpec Integral Field Unit 3–5 m spectral mapping of five young protostars*
S. A. Federman, S. T. Megeath, A. E. Rubinstein, R. Gutermuth, M. Narang, H. Tyagi, P. Manoj, G. Anglada, P. Atnagulov, H. Beuther, T. L. Bourke, N. G. C. Brunken, A. Caratti o Garatti, N. J. Evans, W. J. Fischer, E. Furlan, J. D. Green, N. Habel, L. Hartmann, N. Karnath, P. Klaassen, H. Linz, L. W. Looney, M. Osorio, J. Muzerolle Page, P. Nazari, R. Pokhrel, R. Rahatgaonkar, W. R. M. Rocha, P. Sheehan, **K. Slavicinska**, T. Stanke, A. M. Stutz, J. J. Tobin, Ł. Tychoniec, E. F. van Dishoeck, D. M. Watson, S. Wolk, Y. -L. Yang. *The Astrophysical Journal*, 2024, 966, 41
 19. *JOYS: Disentangling the warm and cold material in the high-mass IRAS 23385+6053 cluster*

- C. Gieser, H. Beuther, E. F. van Dishoeck, L. Francis, M. L. van Gelder, Ł. Tychoniec, P. J. Kavanagh, G. Perotti, A. Caratti o Garatti, T. P. Ray, P. Klaassen, K. Justtanont, H. Linnartz, W. R. M. Rocha, **K. Slavicinska**, L. Colina, M. Güdel, Th. Henning, P. -O. Lagage, G. Östlin, B. Vandenbussche, C. Waelkens, G. Wright. *Astronomy & Astrophysics*, 2023, 679, A108
20. *JWST Observations of Young protoStars (JOYS): Outflows and accretion in the high-mass star-forming region IRAS 23385+ 6053*
H. Beuther, E. F. van Dishoeck, Ł. Tychoniec, C. Gieser, P. J. Kavanagh, G. Perotti, M. L. van Gelder, P. Klaassen, A. Caratti o Garatti, L. Francis, W. R. M. Rocha, **K. Slavicinska**, T. Ray, K. Justtanont, H. Linnartz, C. Waelkens, L. Colina, Th. Greve, M. Güdel, Th. Henning, P. -O. Lagage, B. Vandenbussche, G. Östlin, G. Wright. *Astronomy & Astrophysics*, 2023, 673, A121
21. *Role of suprathreshold chemistry on the evolution of carbon oxides and organics within interstellar and cometary ices*
B. C. Ferrari, **K. Slavicinska**, C. J. Bennett. *Accounts of Chemical Research*, 2021, 54, 1067-1079

Submitted publications as co-author

1. *CORINOS V: Radiative transfer effects in protostellar ice observations*
W. E. Thompson, J. B. Bergner, N. J. Evans, Y. -L. Yang, V. Kreft, L. Anderson, K. Pontoppidan, L. I. Cleeves, E. F. van Dishoeck, R. E. Gross, J. -E. Lee, M. K. McClure, N. Sakai, **K. Slavicinska**. *The Astrophysical Journal*, in press
2. *JOYS+: Analyses of OCN^- , N_2O , NO , and complex cyanides in ices. Thermal processing results in modest enhancement of OCN^- ice*
P. Nazari, N. Brunken, Y. Chen, **K. Slavicinska**, E. F. van Dishoeck, W. R. M. Rocha, A. C. A. Boogert, M. G. Navarro, V. J. M. Le Gouellec, L. Francis, Ł. Tychoniec, A. Caratti o Garatti, C. Gieser, T. P. Greene, P. J. Kavanagh. *Astronomy & Astrophysics*, accepted
3. *Probing the ubiquity of complex ices in protostars with JWST: the first systematic quantification of weak ice bands between 6.8 and 7.9 μm*
Y. Chen, E. F. van Dishoeck, **K. Slavicinska**, Ł. Tychoniec, M. L. van Gelder, L. Francis, A. C. A. Boogert, M. Narang, C. A. Schravendijk, H. Beuther, A. Caratti o Garatti, E. K. Eenhorst, C. Gieser, Th. Henning, M. Guedel, V. J. Le Gouellec, M. K. McClure, P. Nazari, S. Reyes, M. Tolman, Y. -L. Yang. *The Astrophysical Journal Letters*, under review



My first astronomical work (2003).

Curriculum vitae

I was born on January 15, 1997 in Brno, Czech Republic, a city infamous for its comically-shaped astronomical clock. Neither of my parents are astronomers or scientists, but my mother frequently took my brother and me to various public astronomy events in Brno. One of my earliest memories is a visit to the local planetarium, where we watched a movie about Pluto and received a booklet about the (back then) 9 planets of the solar system.

In 2004, my family immigrated to the United States. I did most of my schooling there, but my parents sent my brother and me back to the Czech Republic every summer to live with my grandparents. Eager to explore our new home, my parents also took my brother and me on road trips across the US, during which we visited the Kennedy and Johnson NASA centers. These visits cemented my early fascination with space, but this was only one of my many childhood obsessions – besides an affinity for science (especially chemistry), I also loved writing, visual art, music (I played the clarinet), and theater. As I grew older, I found myself approaching, with increasing stress, a critical crossroads: should I pursue a career in science, or the arts? Encouraged by the support of my high school science teachers, excellent performances in chemistry classes, and an internal pull, I enrolled in a chemistry BS with a physics minor at a college near my family, Kennesaw State University, in fall 2015. Simultaneously, I worked for my family's wedding photography business as a photographer's assistant, photo editor, and wedding album designer. I resolved to maintain high class loads each semester so that I could graduate early and save on college fees. I also worked various jobs throughout, including supplemental chemistry instructor, grocery store cake decorator, and waitress at a French café.

In my second freshman semester, I was eager to start applying the concepts I was learning in my classes to hands-on research. I approached Prof. Dr. Heather Abbott-Lyon to ask to join her research group in *astrochemistry*, which sounded like a perfect topic for my interests. Heather immediately put me to work, getting me trained on the ultrahigh vacuum (UHV) equipment in her lab. KSU had no chemistry PhD students or postdocs, so undergrads like me (and occasional master's students) ran the show in the lab. While such conditions are not optimal for a lab's productivity and output, I believe they are optimal for young students to develop an early sense of independence and empowerment. The Abbott Lab was also a part of the Center for Chemical Evolution (CCE), a consortium of groups from multiple universities studying the chemical origins of life. Being a CCE member gave me the opportunity to go on research visits to other labs at Georgia Tech and University of South Florida, where I worked with PhD students and postdocs and got a taste of what graduate school was like.

I quickly fell in love with research, astrochemistry, and UHV science, and I decided early on that I wanted to continue such research in graduate school. One of the first people I met in the Abbott Lab was a master's student, Danna Qasim, who went on to pursue a PhD in the Laboratory for Astrophysics (LfA) in Leiden University. Danna stayed in touch with me after leaving KSU, and after hearing from her what the LfA was like, I decided to make it my goal to work there one day. However, I also wanted to apply for US citizenship once I became eligible in 2018, and the application required that I continuously lived in the US until I was naturalized. So I devised a plan: I would apply for citizenship at the end of my bachelor's, get a US master's degree while waiting for naturalization, and then apply for a PhD in Leiden. In the meantime, I worked hard to become the perfect LfA PhD candidate. I spent every semester doing research in the lab, worked as a paid research assistant every summer, received several research awards and stipends, and presented at conferences all over

the US, including the Origins of Life Gordon Research Conference in 2018 thanks to a kind invite from CCE collaborator Prof. Dr. Matthew Pasek. I graduated with my BS after 3 years and spent what would have been my final BS year employed as a technician in the Abbott lab.

I filed my application for US citizenship the day I became eligible in November 2018. Around this time, Danna introduced me to Dr. Christopher Bennett at the University of Central Florida, who was looking for graduate students for his new astrochemistry lab. Chris was supportive of my plan and encouraged me to apply to the UCF PhD program and then master out, which would give me a flexible graduation timeline and a better stipend that would allow me to study without needing outside income. So in fall 2019, I entered UCF as a PhD student in physics on the planetary sciences track. In Chris's lab, I worked on a variety of projects, including electron irradiation of cosmic ice analogs and designing a UHV chamber for simulating space weathering of carbonaceous asteroids. Under the latter project, I applied for the NASA FINESST grant, one of the few NASA opportunities available to non-US citizen graduate students, and was awarded it. I also fell in love with Chris's other PhD student, Brian Ferrari (now my husband). Brian was supportive of my dream to go to Leiden and expressed interest in mastering out with me, but I figured there was little chance of two LfA PhD positions being open simultaneously and thus tabled my dream in favor of us being together.

In November 2020, I was finally naturalized as a US citizen. Then, in the spring of 2021, we heard the Leiden LfA was hiring two new PhDs. Given the timing, it seemed like a sign, so Brian and I reached out to Prof. Dr. Harold Linnartz to apply. He told us the positions had just been filled, but that another PhD position had opened for a combined laboratory and observational project to be co-supervised with Prof. Dr. Ewine van Dishoeck, along with an additional PhD opening in the theoretical chemistry group. Ultimately, we were offered and accepted these positions. During my final summer at UCF, I traveled to the University of Lille in France to work with Dr. Claire Pirim on a project analyzing PAHs in carbonaceous chondrite meteorites with a state-of-the-art two-step laser mass spectrometry setup. This work resulted in my first first-author publication, submitted right after I received my master's.

In January 2022, three weeks after the JWST launch, I fulfilled my dream and arrived in the Leiden LfA to conduct a PhD using laboratory and JWST data to analyze the chemical composition of interstellar ices. The PhD was co-supervised by Harold, Ewine, and eventually Dr. Ko-Ju Chuang following Harold's untimely passing in December 2023. Over the past four years, I have worked on a variety of experimental and observational projects that culminated in 5 first-author publications, 2 of which had accompanying press releases, and 20 co-author publications. I conducted experiments on the IRASIS setup and modified it in my final year to include a UV lamp and a quartz crystal microbalance. I learned how to propose for and analyze JWST observations and was awarded 36 total hours as PI of two JWST programs in cycles 3 and 4. I was a member of multiple JWST observing teams including JOYS+, IPA, and HEFE, and worked closely with external collaborators, including Dr. John Tobin at NRAO and Dr. Adwin Boogert at the University of Hawai'i at Manoa, whom I visited on a 2-week research trip. I presented my work in conferences and seminars in the Netherlands, Denmark, Germany, Italy, Spain, and 5 US states. I was also a teaching assistant for the Astronomical Spectroscopy course for 3 semesters and supervised the lab research projects of 4 bachelor students and 3 high school students. Following my defense, I will return to the US to explore the chemical links between interstellar and planetary ices as a Caltech Center for Comparative Planetary Evolution (³CPE) Postdoctoral Fellow with Prof. Dr. Michael Brown.

Acknowledgments

The science in my PhD may have been conducted in physical vacuums, but it was not conducted in social ones. If I had to quantify all the support I have received throughout my life leading up to this milestone, it would be a *quadrillion* times higher than the $\sim 10^{-9}$ mbar vacuum of IRASIS – like the ~ 1000 bar pressures in the deepest parts of the ocean.

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