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From star-formation to recombination: expanding our view of the radio recombination line universe

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List of Publications

First Author

Emig K.L., White G., Salas P., et al. 2021, *Low-Frequency Observations of Diffuse Ionized Gas in Cygnus X*, in preparation.

Emig K.L., Bolatto A., Leroy A., et al. 2020, *Super Star Clusters in the Central Starburst of NGC 4945*, ApJ, 903, 50.

Emig K.L., Salas P., de Gasperin F., et al. 2020, *Searching for the largest bound atoms in space*, A&A, 634, 138.

Emig K.L., Salas P., de Gasperin F., et al. 2019, *The first detection of radio recombination lines at cosmological distances*, A&A, 622, 7.

Emig K.L., Lunardini C., and Windhorst R. 2015, *Do high energy astrophysical neutrinos trace star formation?*, JCAP, 12, 29.

Contributing Author

Levy R., Bolatto A., Leroy A., et al. (including **Emig K.L.**) 2021, *Outflows from Super Star Clusters in the Central Starburst of NGC253*, accepted ApJ (arxiv: 2011.05334)

de Gasperin F., Williams W., Best P., et al. (including **Emig K.L.**) 2021, *The LOFAR LBA Sky Survey I. survey description and preliminary data release*, accepted A&A (arxiv: 2102.09238)

Mandal S., Prandoni I., Hardcastle M., et al. (including **Emig K.L.**) 2021, *Extremely deep 150 MHz source counts from the LoTSS Deep Fields*, accepted A&A (arxiv: 2011.08829)

Lunardini C., Vance G., **Emig K.L.**, et al. 2019, *Are starburst galaxies a common source of high energy neutrinos and cosmic rays?*, JCAP, 063, 319

Salas P., Oonk J., **Emig K.L.**, et al. 2019, *Carbon radio recombination lines from gigahertz to megahertz frequencies towards Orion A*, A&A, 626, 70

de Gaserpin F., Dijkema T., Drabent A., et al. (including **Emig K.L.**) 2019, *Systematic effects in LOFAR data: A unified calibration strategy*, A&A, 622, 5

Shimwell T., Tasse C., Hardcastle M., et al. (including **Emig K.L.**) 2019, *The LOFAR Two-meter Sky Survey. II. First data release*, A&A, 622, 1

Salas P., Oonk J., van Weeren R., et al. (including **Emig K.L.**) 2018, *Mapping low-frequency carbon radio recombination lines towards Cassiopeia A at 340, 148, 54, and 43 MHz*, MNRAS, 475, 2496

Salas P., Oonk J., van Weeren R., et al. (including **Emig K.L.**) 2017, *LOFAR observations of decameter carbon radio recombination lines towards Cassiopeia A*, MNRAS, 467, 2274

Driver S., Andrews S., Davies L., et al. (including **Emig K.L.**) 2016, *Measurements of Extragalactic Background Light from Far UV to Far IR from Deep Ground- and Space-based Galaxy Counts*, ApJ, 827, 108

Trujillo C., Ball J., Boccas M., et al. (including **Emig K.L.**) 2013, *Altair at Gemini North: Full Sky Coverage Laser AO Correction at Visible Wavelengths*, Proceedings of the Third AO4ELT Conference, 51

Cenko S., Li W., Filippenko A., et al. (including **Emig K.L.**) 2012, *Supernova 2012Z in NGC 1309 = Psn J03220535-1523156*, CBET, 3014, 1

Curriculum Vitae

In the fullest sense of the words curriculum vitae, this is a story of my academic life. I was born on the 21st of January 1989 in Norristown, Pennsylvania in the United States of America to Bonnie Daya Emig and Ronald Emig. As a child, I was curious and fascinated to learn — learn about all types of things. How things work. Why they work the way they do. One of my grand visions: image learning and discovering the wonders of the world for your entire life! (Only later did I realize that this is an inherent part of being human.) Early on I showed an aptitude for math and eventually science as it was introduced. I loved working with numbers and the language of mathematics. Knowing the qualities and strengths that I possess now and thinking back to myself as a child, I realize how the basic concept behind the scientific method – hypothesizing, testing, assessing the extent and limitations of results – came so naturally to my mind. I was drawn to, what I perceive as, this "best way" to learn about the physical world. I must confess though, I was a bad student! The older I got, the worse it got. Instead of doing homework, you could more easily find me barefoot, climbing a tree, training in competitive gymnastics, and as I got older, coaching gymnastics, working, or being a mischievous teenager.

After high school I enrolled in the local Montgomery County Community College. It was at "MC3" that I took an introductory astronomy course with Dr. Peter Bachmann. Wow! How awe-inspiring is the beauty of the cosmos? Instead of discovering the wonders of the world, I could discover the wonders of the universe. And I could combine mathematics with scientific rigor to do it! I was hooked. Through the introductory course and the astronomical journals that Dr. Bachmann shared with me, I learned about Mauna Kea and some of the world's best observatories. I was inspired to study astronomy in that environment, and I valued and had a desire to learn about and experience the culture and traditions of native Hawaiians. In deciding to pursue astronomy, I also pledged to myself that I would be an advocate for feminism through leading by example and directly contributing (to enrich women in society) as an involved scientist.

At the University of Hawai'i at Hilo, I completed double majors in astronomy and physics and a minor in mathematics. I became very focused on school work and immersing myself in physics and astronomy, meanwhile I coached and judged gymnastics on nights and weekends. The astronomy community in Hilo and on Mauna Kea was a fantastic environment for a young astronomer in the making. I assisted in observations with the Caltech Submillimeter Observatory and the Sub-millimeter Array and toured many other facilities. I regularly contributed in public outreach activities

connected with the university and the observatories – in elementary schools, at university events, at the shopping mall, at the Visitor Information Station on Mauna Kea, and by setting up solar telescopes at beaches. With the Pacific International Space Center for Exploration Systems (PICSES), I worked with NASA and the Canadian Space Agency on simulated lunar rover missions on Mauna Kea. I gained research experience working with Prof. Marianne Takamiya on star-forming galaxies and as a part of this, observed at the Subaru Telescope. Through the Pacific Undergraduate Research Experience in Mathematics working with Profs. Rebecca and Luis Garcia, Efren Ruiz, and Roberto Pelayo, I investigated the abelian sandpile groups of book graphs. At the CTIO research experience for undergraduates in La Serena, Chile, I worked with Catherine Kaleida on simulated star clusters in Hubble Space Telescope data. During my undergraduate, I also organized an independent study on particle physics, I participated in the William Putnam mathematical competition, and I was awarded the Daniel K. Inouye Scholarship in Astronomy. I was also mentored by Prof. Philippe Binder. I graduated in May 2012, also gaining much appreciation and perspective during this time as a minority in society.

In August 2012, I started an internship at the Gemini (North) Observatory in Hilo. With Dr. Rachel Mason, I investigated low-luminosity AGN and I also helped to recommission the GNIRS instrument. I stayed at Gemini until May 2013. In that time I also worked on an instrument performance monitoring system with Drs. Michael Pohlen and Andre-Nicolas Chene, and I attended two astronomical conferences.

By August 2013, I started a graduate program in astrophysics at Arizona State University in the group of Prof. Rogier Windhorst, Dr. Seth Cohen, and Dr. Rolf Jansen. I was ecstatic to lead and publish my first academic article with Profs. Cecilia Lunardini and Rogier Windhorst on possible counterparts of high energy neutrino events from the IceCube Neutrino Observatory. Another research project at ASU led me to Germany to work (primarily) with Prof. Marcus Brüggen and Dr. Francesco de Gasperin on interferometric radio observations of merging galaxy clusters taken with the Low Frequency Array. I quickly took to calibrating radio data. With this unique and valuable experience and the bright and pioneering future I saw in the radio astronomy community, I was motivated to continue working with LOFAR. I earned a Master of Science in astrophysics in August 2015. During that time, I also was awarded the Dean's Fellowship, assisted in teaching four bachelor courses, secured funding to attend multiple conferences, co-founded a rocketry club, observed at the Kitt Peak National Observatory, served as a Graduate Council Representative peer-elected from more than 100 graduate students, and received honorable mention as a National Science Foundation Graduate Research Fellow.

My journey to earn a PhD from the Leiden Observatory with Profs. Alexander Tielens and Huub Röttgering started in September 2015. I spent the majority of my time and efforts as a PhD researcher leading the development of data processing strategies for extragalactic spectroscopic observations with LOFAR, developing techniques to search for redshifted radio recombination lines, and contributing as a team member to galactic observations of carbon radio recombination lines from diffuse molecular gas and to the LOFAR Surveys Key Science Project. My time as a visiting researcher at the University of Maryland in Fall of 2019 with Prof. Alberto Bolatto was also highly influential to me. I broadened my research base and entered

into a fruitful collaboration.

Throughout my PhD, I developed the tools to navigate academia as an independent researcher, an effective team member, an expert in scientific and technical capabilities, and a public and professional educator. I have published three first author papers in high-profile astronomical journals. I have been the PI and Co-I of dozens of observing proposals for telescopes, helped to supervise two master student projects, assisted in teaching a master course on the interstellar medium for three years, presented research in numerous international conferences, public events, and as a colloquium speaker, participated in and helped to organize technical and scientific workshops, organized public outreach events, authored a children's article, organized the weekly department borrel, and served as a graduate student ambassador. And just when I thought I was in the homestretch, I saw through the completion of two thesis chapters during the global pandemic of 2020. An important aspect of my time in Leiden is that I have also learned the experience of a foreigner in an ambiguous and sometimes insecure environment. As I have done during my PhD, I continue to educate myself about and be a proponent of equitable and oppression-free practices in (academic) organizations.

Starting in December 2020, I am honored to be a postdoctorate Jansky Fellow of the National Radio Astronomy Observatory based in Charlottesville, Virginia, USA. I look forward to honing my leadership skills and developing radio recombination lines as a powerful tool to study the interstellar medium in external galaxies. I continue to be a member of the LOFAR Surveys Key Science Project and Square Kilometer Array working groups. Throughout my academic journey, I have also persevered through multiple occasions of harassment and bullying. I thank the many individuals who have helped me through those experiences and grow in positive ways from them.

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