Science and Technology Facilities Council

IN CONFIDENCE: NARRATIVE CV AND TRACK RECORD

Please refer to the Guidance for applicants for instructions on completing your C.V. The font size and type and margins of the template must not be altered. DO NOT delete any section. However, blank rows and guidance text in italics can be deleted. There is not a prescribed length for each section. The submitted document must be no longer than 4 sides of A4 in total.

Name (title, first name(s), surname):
Dr. Evan H Anders

Employment: Provide details of your employment in chronological order (most recent first)

Dates From	Dates To	Organisation and position held	Type of appointment e.g. permanent, fixed-term, full-time, part-time etc
09/2020	Present	CIERA Postdoc Fellow, Northwestern Univ.	Full-time
06/2020	08/2020	Postdoc Researcher, LASP, CU Boulder	Full-time
09/2018	05/2020	NASA NESSF Fellow, CU Boulder	Full-time student / research
09/2015	08/2018	Hale Graduate Fellow, CU Boulder	Full-time student / research
06/2015	08/2015	Graduate Research Assistant, CU Boulder	Full-time student / research

Education: Undergraduate and postgraduate studies

Dates From	Dates To	University/College attended	Department	Subject	Class of award
09/2014	05/2020	Univ. Colorado, Boulder	Astrophysical & Planetary Sci.	Astrophysical & Planetary Sci.	PhD & MS
09/2010	05/2014	Whitworth University	Physics	Physics	BS

Provide a brief description for the following:

1. How have you contributed to the generation and flow of new ideas, hypotheses, tools or knowledge?

My contributions are summarised by my top five research outputs, ranked here in order of importance and relevance:

1. Anders et al. 2022a, ApJ 926, 169 (“Convective Penetration Paper”)
2. Anders et al. 2022b, ApJL 928, L10 (“Schwarzschild-Ledoux Paper”)
3. Anders et al. 2019, ApJ 884, 65 (“Entropy Rain Paper”)
4. Jermyn, Anders, et al. 2022, ApJ 929, 182 (“Convective Penetration Paper II”)
5. Anders et al. 2018, PRF 3, 083501 (“Accelerated Evolution Paper”)

These papers demonstrate my research breadth, my upward career trajectory, and my approach to research. I decompose complex problems into manageable research questions. I study those questions using direct numerical simulations. Then I use simulation results to learn something about stellar interiors. Papers #1-3 demonstrate this process. I have recently tried to ensure that the results of my simulations apply in a useful way to either the observing or the 1D stellar modelling community (e.g., by providing new or updating old 1D mixing prescriptions), because these communities are much larger than my own (hydrodynamical modelling). Paper #4 shows one such application of my results. Finally, I have developed numerical tools to reduce the computational cost associated with pushing the limits of state-of-the-art simulations, and paper #5 is an example of this.

Last fall, I gathered with top researchers in my field at the “Probes of Transport in Stars” program at KITP. At this program, I learned that members of multiple communities (1D stellar modellers, observers, and 3D hydrodynamicists) are highly interested in convective boundary mixing and its applications. This is why I list my Convective Penetration Paper (#1) as my most highly influential work, and why I propose to study convective boundary mixing during my time at Exeter (please refer to my Case for Support, Focus I). This interest has led to a follow-up paper (#4) which demonstrates that our theory of convective penetration shows promise for resolving discrepancies between observations and models. The Schwarzschild-Ledoux Paper (#2) also came out of this KITP meeting, brought together multiple fields, and addressed a fundamental question in stellar convection.

Earlier in my career, I studied “entropy rain” (#3) as a possible solution to the “solar convective conundrum.” Deep within the Sun’s convection zone, theory and simulations predict that large-scale “giant cells” should be driven, but these flows are not robustly observed, and this is a conundrum. In this work, we tested the hypothesis that the Sun’s luminosity is carried by downflows launched from the solar surface in small “entropy raindrops,” which would not require giant cells to transport the flux. We surprisingly found this hypothesis may be valid.

Finally, in my Accelerated Evolution Paper (#5), I created a tool which evolves convective simulations to their final equilibrated state using a factor of ten fewer computational resources than traditional time stepping methods. This paper showed why it is important for convection simulations to reach a state of energy equilibrium and why it is difficult to achieve this state using traditional time stepping methods for turbulent simulations. This paper also demonstrated that my alternative, fast method achieved the same statistically stationary state as (slow) traditional time stepping. This study created foundational numerical tools that enabled the science in papers #1 and #2.

Beyond published papers, I have contributed open source dynamical simulation scripts, plotting scripts, and datasets to the community; all of the code and simulation tools used in my first-author papers are available online at my github: https://github.com/evanhanders/. I value open-source and widely-accessible code, so I regularly publish both my simulation code (e.g., on Github) and relevant data outputs (e.g., on Zenodo).

My work has recently garnered external recognition from my peers. I was invited to lead a review chapter (in prep) on convective boundary mixing as part of a collection of reviews stemming from last fall’s KITP program. I have been invited to give research seminars at Princeton and the Kavli Summer Program; this fall I will give research seminars at Caltech, the CCA, and Durham University, and I will deliver an Astrophysics colloquium at the University of Wisconsin, Madison.

I have a track record of applying for and receiving funding to pursue my own research goals. I was awarded two sequential fellowships as a master’s and PhD student: the George Ellery Hale fellowship and the NASA NESSF fellowship. After my PhD, I was awarded the Northwestern CIERA fellowship. These prize fellowships have afforded me the privilege of pursuing research questions that I find compelling and the opportunity to build my own research program and an international network of collaborators.

2. How have you demonstrated your potential to lead your research field?

I have demonstrated my potential to lead my field in many ways. I have of course demonstrated my ability to develop impactful research projects which attract funding (see response #1). The research proposed in my Case for Support will be the foundation upon which I build my future research profile. I have also invested myself in the collaborative and interpersonal aspects of being an academic, and I have gained experience interfacing with the administrative processes which make every part of our work possible.

I work hard to build strong relationships with research collaborators throughout the world. I have found that collaboration is the most productive way to formulate new research projects and to improve the quality of my own research. All of my top five research outputs discussed in the previous section involved collaborators both inside and outside of my host institution, and the same is true for all ongoing research that I have underway.

Mentorship and the development of early career scientists is a crucial aspect of being a leader in academia, and I have sought opportunities to gain mentorship experience. I currently co-mentor 5 graduate students (3 at Northwestern, 2 at CU Boulder). I meet weekly with these students to help them with their research, paper writing, fellowship proposal writing, etc. Two of these students are working on projects where I am the primary scientific mentor; these projects are nearing publication, and should be submitted for review this fall.

I also consistently involve myself in committee work and departmental service. As a graduate student at the University of Colorado, I served as a voting member of the graduate admissions committee for two years, and led the development of the first rubric for the graduate admissions process. As a postdoc at CIERA, I chaired CIERA's K12 education and public outreach taskforce, which restructured CIERA's outreach organisation by streamlining the volunteer process, and by setting up a new committee for oversight of future outreach initiatives.

I am starting to gain experience with mechanisms for interfacing between academia and both government and outside businesses. I co-authored a recently-submitted solar decadal review white paper which may help ensure funding availability for work on rotating convection in the solar context. At CIERA, as part of the JEDI (Justice, Equity, Diversity, and Inclusion) committee, I have helped contract an external business to conduct an impartial climate survey of CIERA.

Finally, since receiving my PhD I have served as a referee on four journal articles for prestigious and cross-disciplinary journals (*Nature Scientific Reports, Journal of Fluid Mechanics, Journal of Atmospheric Sciences)*, and I have also served as a referee for a DIRAC computing proposal.

3. How have you contributed to the wider research and innovation community?

I contribute to the wider research and innovations community by presenting my results in specialised and interdisciplinary conferences, by mentoring and developing early career scientists, by developing myself as a communicator and professional, and by participating in education and public outreach initiatives.

I publicise my results to fellow experts by presenting talks and posters at conferences. Every year, I attend the interdisciplinary APS Division of Fluid Dynamics conference in addition to smaller conferences on stellar fluid dynamics (e.g., Stellar Hydro Days, Compressible Convection Conference, KITP workshops).

I invest my time and effort in developing early career scientists. I currently co-mentor five graduate research assistants, with whom I meet regularly. I was the primary mentor of a student at the 2021 Kavli Summer Program in Astrophysics, and will continue to work with that student to bring that work to a publication in the coming year. I have also co-mentored undergraduate students (most recently one REU student during summer 2021). In addition to formal research mentoring, I participate in CIERA's mentorship network, wherein I meet ~once a month with undergraduate and graduate students, and I help these students network, discuss career pathways, plan and write fellowship proposals, etc.

I seek out professional development opportunities in order to be the best leader, communicator, and teacher I can be. I was the 2016-17 astrophysics "Lead Graduate Teacher" through CU Boulder's Graduate Teacher Program. In this role, I attended workshops on teaching pedagogy, led a workshop on values affirmation interventions, and facilitated one-on-one video teaching consultations for graduate teachers. In 2017 and 2019, I attended UCSC ISEE's Professional Development Program, which taught me about inquiry & assessment in the classroom, introduced me to the education literature on equity & inclusion in physics, and taught me leadership skills like how to run productive meetings. As a graduate student, I co-instructed an Introduction to Python Programming class, during which my fellow co-instructor and I worked collaboratively to overhaul the course curriculum on backwards design principles. Northwestern participates in the CIRTL network, and this year I participated in the "Introduction to Evidence-Based Undergraduate STEM Teaching" MOOC, from which I learned many modern pedagogical techniques.

I enjoy interfacing with the general public and K-12 students through education and public outreach initiatives. I helped lead CU Boulder's "CU STARs" outreach program from 2016-2019, which visited high school classrooms in underserved communities across Colorado, providing undergraduate students opportunities to teach high school students about science. At Northwestern I formed connections between the CIERA astrophysics institute and the Baxter Center for Science Education (BCSE). CIERA now hosts a yearly "astronomy day" workshop for BCSE's Summer Scholars program, which exposes underrepresented high school students to information about the variety of STEM career pathways available to them. I also developed an exoplanets "Pathfinder" for CIERA, which is a printable pamphlet targeted at the general public which can be printed and distributed at outreach events.

I strive to make my science interesting and approachable to experts and novices alike through creative and careful presentation of my results. Some examples of visualisations of my research can be found online at https://vimeo.com/evanhanders. In the future, I hope to increase accessibility to my scientific results by sonifying them (presenting my results using sound). In particular, I am currently studying gravity waves in massive stars; there is a very clear parallel between gravity waves and sound waves, and this provides me an excellent opportunity to explain my unintuitive science in terms that people are familiar with.

4. Additional Information:

N/A