

Curriculum Vitae
Michael Y. Grudić
NASA Hubble Fellow

Carnegie Observatories
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Education

Ph.D. in Physics 2014-2019
California Institute of Technology (Caltech)
Dissertation: *The Role of Stellar Feedback in Star Cluster Formation*[†]
Adviser: Dr. Philip F. Hopkins

B.Sc. (Honours) in Physics and Applied Mathematics 2009-2014
Memorial University of Newfoundland (MUN)
Dissertation: *Gravitational Scattering in the Relativistic Kepler Problem*
Adviser: Dr. John Lewis

Positions

NASA Hubble Fellow, Carnegie Observatories Sept 2021-
CIERA Postdoctoral Fellow, Northwestern University Sept 2019-Aug 2021

Research Interests

- Theoretical astrophysics
- Numerical techniques for astrophysical simulations.
- Star formation, and the physical origins of stellar masses, clustering, and multiplicity.
- Origins and evolution of giant molecular clouds, and the effects of stellar feedback upon them.
- Realistic sub-grid modeling of star formation, ISM physics, and feedback in galaxy simulations.
- Evolution of dense stellar systems, including the production of exotic stars and gravitational wave sources.

Academic Honors

NASA Hubble Postdoctoral Fellowship	2021
CIERA Postdoctoral Fellowship	2019
[†] Caltech Robert F. Christy Prize for Outstanding Doctoral Thesis in Theoretical Physics	2019
Caltech James A. Cullen Memorial Fellowship for Excellence in Physics	2017
MUN Medal for Excellence in Physics	2014
MUN Medal for Excellence in Applied Mathematics	2014
Daniel Freeman Memorial Scholarship	2014
Lou Visentin Award	2014
NSERC Undergraduate Summer Research Award	2011-2013
Mrs. E.D. Matthews Memorial Scholarship in Mathematics and Statistics	2013
MUN Faculty of Science Dean's Book Prize (Physics)	2013
Dr. S. W. Brekon Scholarship in Physics	2012-2013
Flight 491 Legacy Scholarship	2011-2013
MUN Faculty of Science Dean's List	2011-2013
Dr. Vincent P. Burke Scholarship	2012
Centenary of Responsible Government Scholarship	2012

Computing Awards

Frontera LRAC, "STARFORGE: Simulating star formation with realistic physics and feedback" – 42M CPU-h awarded to date (PI) 2021-2023
Frontera Pathways, "Exploring the Physical Ingredients of Star Formation with Simulations" – 14M CPU-h (PI) 2020-2021
XSEDE AST190018, "Simulating the Life of a GMC" – 28M CPU-h (co-PI) 2020-2021

Selected Scientific Presentations

"Our Galactic Ecosystem", Lake Arrowhead, CA, USA. Contributed talk. 2022
Harvard-Smithsonian Center for Astrophysics Seminar. Virtual invited seminar. 2022
Origins Workshop - ISM, Star and Cluster Formation, Salt Lake City, UT, USA. Contributed talk. 2022
Ringberg Virtual Seminar Series. Contributed talk. 2021
362nd IAU Symposium (virtual). Contributed talk. 2021
"Star Formation: From Clouds to Discs", Dublin, Ireland. Contributed talk. 2021
University of Sao Paulo Institute of Astronomy Seminar. Invited seminar. 2021
Los Alamos Astrophysics Seminar Series. Invited seminar. 2021
236th AAS Meeting (virtual). Invited talk. 2020
IAU Symposium 351: "Star Clusters: from the Milky Way to the Early Universe", Bologna. Contributed talk. 2019
Princeton SFIR Seminar, Princeton, NJ, USA 2018
MIT Astrophysics Brown Bag Lunch, Cambridge, MA, USA 2018
"Galaxy Formation and Evolution in Southern California", Pasadena, CA, USA. Contributed talk. 2018
MPA Cosmology Seminar, Garching, Germany 2018
"Formation of Globular Clusters at High and Low Redshift", Sexten, Italy. Invited opening keynote. 2018
"Multi-scale physics of SF & feedback during galaxy formation", Heidelberg, Germany. Invited talk. 2018
UT Austin Theory Seminar, Austin, TX, USA 2018
CIERA Theory Group Meeting, Evanston, IL, USA 2018
231st AAS Meeting, Washington, D.C., USA. Contributed talk and poster. 2018
CITA Seminar, Toronto, ON, Canada 2017
"Modeling Dense Stellar Systems", Prague, Czechia. Contributed talk. 2017

Teaching

Graduate Teaching Assistant, Caltech 2014-2019

- Analog Electronics Lab
- Sophomore Experimental Physics Lab
- Computational Physics Lab

Undergraduate Teaching Assistant, MUN 2012-2014

- General Physics I: Mechanics
- General Physics II: Waves, Oscillations and Electromagnetism
- Mathematics Help Centre
- Engineering Help Centre

Personal tutor in mathematics, physics, and chemistry at secondary and post-secondary levels 2008-2012

Outreach and Service

Caltech Astronomy Outreach 2015-2019

Organizing and volunteering at public astronomy outreach events. Leading a team of telescope operators during public stargazing events, contributing to Q&A panels, and giving informal "Astronomy on Tap" talks.

Summer App Space - Lab Instructor

Summer 2017

Served as an instructor in a summer program in which high school students were taught basic programming and data analysis skills. Mentored a team of students in an open-ended final project.

MUN Physics and Physical Oceanography Society Treasurer

2012-2014

Organized regular social events and study resources for physics students at MUN. Managed the accounts of the Society.

First-Author Publications

Published

- [1] Grudić, M. Y., Guszejnov, D., Offner, S. S. R., Rosen, A. L., Raju, A. N., Faucher-Giguère, C.-A., and Hopkins, P. F. “The dynamics and outcome of star formation with jets, radiation, winds, and supernovae in concert.” *MNRAS*, **512**, 1, 216–232, May 2022. doi:10.1093/mnras/stac526.
- [2] Grudić, M. Y. “Accelerating self-gravitating hydrodynamics simulations with adaptive force updates.” *MNRAS*, **507**, 1, 1064–1071, October 2021. doi:10.1093/mnras/stab2208.
- [3] Grudić, M. Y., Kruijssen, J. M. D., Faucher-Giguère, C.-A., Hopkins, P. F., Ma, X., Quataert, E., and Boylan-Kolchin, M. “A model for the formation of stellar associations and clusters from giant molecular clouds.” *MNRAS*, **506**, 3, 3239–3258, September 2021. doi:10.1093/mnras/stab1894.
- [4] Grudić, M. Y., Guszejnov, D., Hopkins, P. F., Offner, S. S. R., and Faucher-Giguère, C.-A. “STARFORGE: Towards a comprehensive numerical model of star cluster formation and feedback.” *MNRAS*, **506**, 2, 2199–2231, September 2021. doi:10.1093/mnras/stab1347.
- [5] Grudić, M. Y. and Gurvich, A. B. ““pytreegrav”: A fast python gravity solver.” *Journal of Open Source Software*, **6**, 68, 3675, 2021. doi:10.21105/joss.03675.
- [6] Grudić, M. Y. and Hopkins, P. F. “A general-purpose time-step criterion for simulations with gravity.” *MNRAS*, **495**, 4, 4306–4313, May 2020. doi:10.1093/mnras/staa1453.
- [7] Grudić, M. Y., Boylan-Kolchin, M., Faucher-Giguère, C.-A., and Hopkins, P. F. “The universal acceleration scale from stellar feedback.” *Monthly Notices of the Royal Astronomical Society: Letters*, **496**, 1, L127–L132, 06 2020. ISSN 1745-3925. doi:10.1093/mnrasl/slaa103.
- [8] Grudić, M. Y. and Hopkins, P. F. “The elephant in the room: the importance of the details of massive star formation in molecular clouds.” *MNRAS*, **488**, 2, 2970–2975, September 2019. doi:10.1093/mnras/stz1820.
- [9] Grudić, M. Y., Hopkins, P. F., Lee, E. J., Murray, N., Faucher-Giguère, C.-A., and Johnson, L. C. “On the nature of variations in the measured star formation efficiency of molecular clouds.” *MNRAS*, **488**, 2, 1501–1518, September 2019. doi:10.1093/mnras/stz1758.
- [10] Grudić, M. Y., Hopkins, P. F., Quataert, E., and Murray, N. “The maximum stellar surface density due to the failure of stellar feedback.” *MNRAS*, **483**, 4, 5548–5553, March 2019. doi:10.1093/mnras/sty3386.
- [11] Grudić, M. Y., Guszejnov, D., Hopkins, P. F., Lamberts, A., Boylan-Kolchin, M., Murray, N., and Schmitz, D. “From the top down and back up again: star cluster structure from hierarchical star formation.” *MNRAS*, **481**, 1, 688–702, November 2018. doi:10.1093/mnras/sty2303.
- [12] Grudić, M. Y., Hopkins, P. F., Faucher-Giguère, C.-A., Quataert, E., Murray, N., and Kereš, D. “When feedback fails: the scaling and saturation of star formation efficiency.” *MNRAS*, **475**, 3, 3511–3528, April 2018. doi:10.1093/mnras/sty035.

Publications with major contributions

Works made possible by student mentoring, code, or major scientific contributions by MYG.

- [1] Lane, H. B., **Grudić, M. Y.**, Guszejnov, D., Offner, S. S. R., Faucher-Giguère, C.-A., and Rosen, A. L. “Less wrong: a more realistic initial condition for simulations of turbulent molecular clouds.” *arXiv e-prints*, arXiv:2110.14816, October 2021.
- [2] Shi, Y., **Grudić, M. Y.**, and Hopkins, P. F. “The mass budget for intermediate-mass black holes in dense star clusters.” *Monthly Notices of the Royal Astronomical Society*, **505**, 2, 2753–2763, 05 2021. ISSN 0035-8711. doi:10.1093/mnras/stab1470.
- [3] Gurvich, A. B., Faucher-Giguère, C.-A., Richings, A. J., Hopkins, P. F., **Grudić, M. Y.**, Hafen, Z., Wellons, S., Stern, J., Quataert, E., Chan, T. K., Orr, M. E., Kereš, D., Wetzel, A., Hayward, C. C., Loebman, S. R., and Murray, N. “Pressure balance in the multiphase ISM of cosmologically simulated disc galaxies.” *MNRAS*, **498**, 3, 3664–3683, August 2020. doi:10.1093/mnras/staa2578.
- [4] Guszejnov, D., **Grudić, M. Y.**, Hopkins, P. F., Offner, S. S. R., and Faucher-Giguère, C.-A. “Can magnetized turbulence set the mass scale of stars?” *MNRAS*, **496**, 4, 5072–5088, July 2020. doi:10.1093/mnras/staa1883.
- [5] Guszejnov, D., **Grudić, M. Y.**, Offner, S. S. R., Boylan-Kolchin, M., Faucher-Giguère, C.-A., Wetzel, A., Benincasa, S. M., and Loebman, S. “Evolution of giant molecular clouds across cosmic time.” *MNRAS*, **492**, 1, 488–502, February 2020. doi:10.1093/mnras/stz3527.
- [6] Hopkins, P. F., **Grudić, M. Y.**, Wetzel, A., Kereš, D., Faucher-Giguère, C.-A., Ma, X., Murray, N., and Butcher, N. “Radiative stellar feedback in galaxy formation: Methods and physics.” *MNRAS*, **491**, 3, 3702–3729, January 2020. doi:10.1093/mnras/stz3129.
- [7] Ma, X., **Grudić, M. Y.**, Quataert, E., Hopkins, P. F., Faucher-Giguère, C.-A., Boylan-Kolchin, M., Wetzel, A., Kim, J.-h., Murray, N., and Kereš, D. “Self-consistent proto-globular cluster formation in cosmological simulations of high-redshift galaxies.” *MNRAS*, February 2020. doi:10.1093/mnras/staa527.
- [8] Rodriguez, C. L., Kremer, K., **Grudić, M. Y.**, Hafen, Z., Chatterjee, S., Fragione, G., Lamberts, A., Martinez, M. A. S., Rasio, F. A., Weatherford, N., and Ye, C. S. “GW190412 as a Third-generation Black Hole Merger from a Super Star Cluster.”, June 2020. doi:10.3847/2041-8213/ab961d.
- [9] Hopkins, P. F. and **Grudić, M. Y.** “Numerical problems in coupling photon momentum (radiation pressure) to gas.” *MNRAS*, **483**, 3, 4187–4196, March 2019. doi:10.1093/mnras/sty3089.

Other Co-authored Publications

- [1] Yu, S., Bullock, J. S., Wetzel, A., Sanderson, R. E., Graus, A. S., Boylan-Kolchin, M., Nierenberg, A. M., **Grudić, M. Y.**, Hopkins, P. F., Kereš, D., and Faucher-Giguère, C.-A. “Stars made in outflows may populate the stellar halo of the Milky Way.” *MNRAS*, March 2020. doi:10.1093/mnras/staa522.
- [2] Guszejnov, D., Hopkins, P. F., and **Grudić, M. Y.** “Universal scaling relations in scale-free structure formation.” *MNRAS*, **477**, 4, 5139–5149, July 2018. doi:10.1093/mnras/sty920.
- [3] Guszejnov, D., Hopkins, P. F., **Grudić, M. Y.**, Krumholz, M. R., and Federrath, C. “Isothermal Fragmentation: Is there a low-mass cut-off?” *MNRAS*, **480**, 1, 182–191, October 2018. doi:10.1093/mnras/sty1847.
- [4] Hopkins, P. F., Wetzel, A., Kereš, D., Faucher-Giguère, C.-A., Quataert, E., Boylan-Kolchin, M., Murray, N., Hayward, C. C., Garrison-Kimmel, S., Hummels, C., Feldmann, R., Torrey, P., Ma, X., Anglés-Alcázar, D., Su, K.-Y., Orr, M., Schmitz, D., Escala, I., Sanderson, R., **Grudić, M. Y.**, Hafen, Z., Kim, J.-H., Fitts, A., Bullock, J. S., Wheeler, C., Chan, T. K., Elbert, O. D., and Narayanan, D. “FIRE-2 simulations: physics versus numerics in galaxy formation.” *MNRAS*, **480**, 1, 800–863, October 2018. doi:10.1093/mnras/sty1690.

- [5] Kim, J.-h., Ma, X., **Grudić, M. Y.**, Hopkins, P. F., Hayward, C. C., Wetzel, A., Faucher-Giguère, C.-A., Kereš, D., Garrison-Kimmel, S., and Murray, N. “Formation of globular cluster candidates in merging proto-galaxies at high redshift: a view from the FIRE cosmological simulations.” *MNRAS*, **474**, 3, 4232–4244, March 2018. doi: 10.1093/mnras/stx2994.
- [6] Foucart, F., Buchman, L., Duez, M. D., **Grudić, M. Y.**, Kidder, L. E., MacDonald, I., Mroue, A., Pfeiffer, H. P., Scheel, M. A., and Szilagyi, B. “First direct comparison of nondisrupting neutron star-black hole and binary black hole merger simulations.” *Phys. Rev. D*, **88**, 064017, September 2013. doi:10.1103/PhysRevD.88.064017.