Curriculum Vitae

Michael Y. Grudić

NASA Hubble Fellow

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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" – 11M CPU-h (PI) *2021-2022*
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

Ringberg Virtual Seminar Series. Contibuted talk. *2021* 362nd IAU Symposium (virtual). Contribued 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-seconday 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. "Accelerating self-gravitating hydrodynamics simulations with adaptive force updates." MNRAS, **507**, 1, 1064–1071, October 2021. doi:10.1093/mnras/stab2208.

[2] 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.

[3] 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.

[4] 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.

[5] 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.

[6] 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.

[7] 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.

[8] 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.

[9] 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.

[10] 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.

[11] 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-Gigère, 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., Sand erson, 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.