

# Taeho Ryu

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CONTACT INFORMATION	The Max-Planck Institute for Astrophysics, Karl-Schwarzschild-Str. 1 85748, Garching, Germany	<i>E-mail:</i> tryu@mpa-garching.mpg.de <i>Phone:</i> +1 5515740406, +49 1743130001 <i>Citizenship :</i> Korean citizen U.S. legal permanent resident
RESEARCH	<b>Primary interests:</b> time domain astronomy, multi-messenger transients, tidal disruption events, gravitational waves, formation of runaway/hypervelocity stars, supermassive black hole binaries, formation and interaction of black holes in the early universe - AGN & high-mass X-ray binaries, dynamics of stellar clusters, exoplanets.  <b>Methods:</b> relativistic and Newtonian magnetohydrodynamics simulation, $N$ -body simulations, time-dependent Fokker-Planck integrator, stellar evolution simulation	
PROFESSIONAL EXPERIENCE	<b>The Max-Planck Institute for Astrophysics - MPA, Germany</b> MPA prize fellow	2021 – present
	<b>Johns Hopkins University - JHU, USA</b> Postdoctoral research fellow	2018 – 2021
	<b>Korea Institute for Advanced Study - KIAS, South Korea</b> Research assistant to Prof. Kimyeong Lee (Department of Physics)	2011 – 2012
EDUCATION	<b>Stony Brook University - SBU, USA</b> Ph.D., Physics, 2018 (Advisor: Prof. Rosalba Perna) M.A., Physics, 2014	2012 – 2018
	<b>Seoul National University - SNU, South Korea</b> B.S. in Chemistry & Physics (Double-major/Cum Laude) Teaching practicum in Chemistry ★2 years of mandatory military service	2005 – 2011
HONORS, AWARDS AND AFFILIATION	<b>Dresden Prize</b> (for outstanding theoretical thesis), SBU	05/2018
	<b>Peter B. Kahn Fellowship</b> , SBU	05/2016
	<b>SNUANY Scholarship Award</b> , SNU Alumni Association of Greater New York	11/2014
	<b>SNUANY Scholarship Award</b> , SNU Alumni Association of Greater New York	12/2013
	<b>Benjamin Lee Award</b> , SBU	05/2013
	<b>SNU Outstanding Student award</b> (Twice winner), SNU	2009 - 2010
	<b>National Scholarship for Science &amp; Engineering</b> (Thrice winner)	2009 - 2010
	<b>Scholarship for Superior Academic Performance</b> (Five-time winner), SNU	2005 - 2007
SUPERCOMPUTING ALLOCATIONS	<b>Principal Investigator:</b> <i>HLRS</i> (Stuttgart tier 1), project name : <i>Global Relativistic Magnetohydrodynamics Simulations of the Long-term Evolution of Tidal Debris in Tidal Disruption Events of Stars</i> , amount : <b>55M</b> cpu hours on Hawk	

★ annual report selected for presentation with publication in the proceedings of 2023 HLRS Review workshop.

**Project Manager (Principal Investigator: Volker Springel):** *NHR@FAU* (tier 2), project name : *Transient formation in three-body encounters between stars and black holes*, amount : **3.6M** cpu hours on Fritz

INVITED TALKS	<b>Department Seminar</b> , the Univeristy of the Balearic Islands, Spain	12/2023
	<b>Astronomy Seminar</b> , the Univeristy of Nova Gorica, Slovenia	11/2023
	<b>Department Colloquium</b> , Kyung Hee University, Korea	11/2023
	<b>Plasma Physics Seminar</b> , Max Planck Institute for Plasma Physics, Germany	11/2023
	<b>Department Colloquium</b> , SNU, Korea	10/2023
	<b>Colloquium</b> , Korea Astronomy & Space Science Institute, Korea	10/2023
	<b>Lagrange Seminar</b> , Lagrange Laboratoire, France	09/2023
	<b>Astronomy Seminar</b> , Max-Planck Institute for Gravitational Physics(AEI), Germany	09/2023
	<b>Special Seminar</b> , New York University, USA	09/2023
	<b>Astronomy Seminar</b> , Columbia, USA	09/2023
	<b>Astronomy Seminar</b> , Stony Brook University, USA	09/2023
	<b>Special Seminar</b> , Northwestern University(CIERA), USA	08/2023
	<b>MPA/Kavli Summer Program Seminar</b> , MPA, Germany	06/2023
	<b>HUJI Astrophysics Seminar</b> , HUJI, Isreal	03/2023
	<b>2022 MIAPP Conference “The Fundamental Role of Stellar Multiplicity in Stellar Dynamics and Evolution”</b> , MIAPP, Germany	11/2022
	<b>Department Colloquium</b> , University of Tübingen, Germany	07/2022
	<b>Black Hole Workshop</b> , Niels Bohr Institute, Denmark	06/2022
	<b>MPA Seminar</b> , MPA, Germany	10/2021
	<b>Astro UdeC Seminar</b> , the Universidad de Concepción, Chile	04/2021
	<b>CTC Seminar</b> , University of Maryland, USA	06/2019
	<b>Wine&amp; Cheese Seminar</b> , JHU, USA	04/2019
	<b>Department Seminar</b> , SBU, USA	04/2018
	<b>Numerical Scattering Workshop</b> , Flatiron Institute, USA	12/2017
	<b>Black Hole Network Workshop</b> , Flatiron Institute, USA	12/2016
	<b>MODEST-16 NYC Gas and Gravitational Dynamics</b> , USA	09/2016
	<b>Frontier Research in Astrophysics – II</b> , Italy	05/2016
	<b>Astronomy Seminar</b> , Columbia University, USA	05/2016
CONTRIBUTED TALKS	<b>Korean Astronomical Society Fall Meeting</b> , KAS, Korea	10/2023
	<b>Two in a Million</b> , ESO, Germany	09/2023

	<b>MODEST23</b> , Northwestern University, USA	08/2023
	<b>European Astronomical Society Annual Meeting</b> , Krakow, Poland	07/2023
	<b>The Black Holes and Gravitational Waves Munich Day</b> , Germany	05/2023
	<b>Aspen Workshop “Extreme Black Holes”</b> , USA	03/2023
	<b>WE Heraeus-EAS Early Career Researchers in Astr. Workshop</b> , Germany	03/2023
	<b>XMM-Newton Workshop 2022</b> , Spain	06/2022
	<b>Growing Black Holes: Accretion and Mergers</b> , Nepal	05/2022
	<b>SESTAS Meeting</b> , MPA	10/2021
	<b>HotSci@JHU/STScI</b> , STScI	08/2021
	<b>European Astronomical Society Annual Meeting</b> , Leiden	07/2021
	<b>Tidal Disruptions in Kyoto: Confronting Theory with Observations</b> , Kyoto University, Japan	01/2020
POSTERS	<b>Distorted Astrophysical disks</b> , University of Cambridge	05/2021
	<b>The 7<sup>th</sup> Annual Johns Hopkins Postdoctoral Conference</b> , JHU	04/2021
STUDENT SUPERVISION	Alonso Herrera (Master’s student, co-supervising with Prof. Nathan Leigh)	2021-present
	Institute: Universidad de Concepción, Chile Project: Identification of runaway stars using Gaia data Method: Analytic estimates for ejection velocity, analysis of Gaia data	
	Magdalena Andrea Vilaxa Campos (Master’s student, co-supervising with Prof. Nathan Leigh)	2022-present
	Institute: Universidad de Concepción, Chile Project: Stream penetration into mass accretor in Roche-lobe overflow in interacting binaries Method: Analytic estimates and hydrodynamics simulations	
	Kaitlyn Szekerczes (PhD student, co-supervising with Prof. Sherry Suyu)	2022-present
	Institute: formerly a fulbright fellow at MPA, now at Pennsylvania State University Project: Estimate of strongly-lensed tidal disruption event detection rate by LSST Method: Monte-Carlo simulations for gravitational lensing	
	Pavan Vynatheya (PhD student, co-supervising with Dr. Rüdiger Pakmor, Prof. Selma de Mink)	2022-present
	Institute: MPA Project: Remnant properties of partially disrupted stars by stellar-mass black holes Method: Stellar evolution and hydrodynamics simulations	
CERTIFICATION	Korean National Teacher Certification	2011

TEACHING EXPERIENCE	<b>Lecturer</b> , MPA, Germany	08/2017
	Delievered a lecture for hydrodynamics at the MPA/Kavli Summer Program	
	<b>Lecturer</b> , MPA, Germany	06/2017
	Delievered lectures for hydrodynamics and led tutorial sessions at a one-day workshop for hydrodynamics simulations at MPA	
	<b>Guest lecturer</b> , AST200 Course by Prof. Jim Koda, SBU, USA	02/2017
	Delivered a lecture for black holes to undergraduate students	
	<b>Teaching Assistant</b> , Department of Physics and Astronomy, SBU, USA	2012-2014
	Prepared physics lab experiments and assisted students in conducting experiments	
<b>Teacher</b> , Seoul National University Girls' Middle School, South Korea	Spring 2011	
Taught middle-school students chemistry as part of the teaching practicum course		
<b>Teaching Assistant</b> , Language Education Institute, SNU, South Korea	Spring 2011	
Volunteer work to assist students who are hearing impaired in their coursework.		
<b>Lecturer</b> , Central Library, SNU, South Korea	Spring 2009	
Voluneteer work to enhance librarians' grasp of basic scientific concepts in chemistry and physics		
<b>Lecturer</b> , Hansung high school, South Korea	Spring 2009	
Volunteer work to each mathematics for high-school students		
PROFESSIONAL SERVICE	Referee for <i>Monthly Notices of the Royal Astronomical Society</i> , <i>The Astrophysical Journal</i> , <i>Publications of the Astronomical Society of the Pacific</i>	
	NASA (2023), member of panel review	
	IMPRS (2023), member of PhD application review	
PRESS RELEASE	<b>Close Encounters of stars with the black hole binaries kind</b>	2/2023
	- Astrobites: <a href="https://astrobites.org/2023/02/02/close-encounters-of-stars-with-the-black-hole-binaries-kind">https://astrobites.org/2023/02/02/close-encounters-of-stars-with-the-black-hole-binaries-kind</a>	
	<b>Supercomputer Simulations Test Star-destroying Black Holes</b>	11/2021
	- Making a movie in collaboration with NASA for the annual event "Black Hole Friday"	
	- Official webpage: <a href="https://svs.gsfc.nasa.gov/14000">https://svs.gsfc.nasa.gov/14000</a>	
	- ~0.3M views on YouTube in less than a week ( <a href="https://www.youtube.com/watch?v=ALnlZcRoQDY&amp;t=23s">https://www.youtube.com/watch?v=ALnlZcRoQDY&amp;t=23s</a> )	
	- Articles in public science media: Phys.org, Sciencealert.com, the Jerusalem Post, SciTechDaily and so on.	
SCIENTIFIC OUTREACH EXPERIENCE	<b>Girls' day</b> , MPA	04/2023
	Preparation and execution of one of the five sessions where a group of high-school female students complete a given scientific task.	

	<b>SEDS Celestia</b> , BITS Pilani	01/2023
	Invited public lecture about black hole and tidal disruption event	
	<b>Member of the MPA Planetarium Team</b>	04/2022 - present
	Present a planetarium show, public science lecture or talk to students visiting MPA	
	<b>The Johns Hopkins Korean Graduate Student Association</b> , JHU	09/2019
	Invited public talk for Networking night (annual event)	
LEADERSHIP EXPERIENCE	<b>Organizer of AREPO tutorial workshop</b> , MPA	06/2023
	Role: Organize and conduct 1-day AREPO tutorial workshop (20 participants) for stellar astrophysics application of AREPO, consisting of lectures for the introduction to hydrodynamics simulations and exercise	
	<b>Seminar organizer</b> , the Stellar Department at MPA	09/2021 - 09/2022
	Role: invite speakers (typically two speakers for each week), schedule seminars and chair the sessions for talks and discussions (along with two other organizers)	
	<b>Department of Chemistry</b> , SNU, South Korea	2005 - 2006
	Department Activities Representative and Organizer (Student competitions, membership training, freshmen welcoming, etcetera)	
	<b>SNU Campus Life and Culture Center</b> , SNU, South Korea	2010 - 2011
	Mentor-team Manager in SNU Compliance/Mentoring Program Elected Leader (20 members, My team chosen Best Team of the Year)	
COMPUTATIONAL EXPERIENCE	<b>Computing Skills:</b> Fortran, C/C++, Python	
	<b>Code:</b> code-testing of multi-domain infrastructure PATCHWORKMHD, usage of GRMHD code HARM3D, Moving-mesh magnetohydrodynamics code AREPO ( <a href="https://arepo-code.org/">https://arepo-code.org/</a> ), Newtonian AMR hydrodynamics code CASTRO ( <a href="https://amrex-astro.github.io/Castro/">https://amrex-astro.github.io/Castro/</a> )	
	<b>Analysis:</b> Python, Matplotlib, Paraview, Mathematica	
	<b>High Performance computing:</b> USA (Frontera, Stampede, Rockfish, Seawulf), Germany (Hawk hls, SuperMUC Leibniz, Cobra, Raven, Freya)	
AFFILIATION	<b>Junior Member</b> of the International Astronomical Union	06/2022 - present
	<b>Member</b> of LISA consortium	11/2022 - present
	<b>Member</b> of the Korean Science-Engineering Association	09/2014 - present
NON-SCIENTIFIC OUTREACH EXPERIENCE	<b>SNU Obstacle Person Support Center</b> , SNU	Spring 2009
	Assistant to a hearing-impaired student, and provider of study aid	
	<b>Kyujanggak Institute for Korean Studies</b> , SNU	Spring 2011
	Docent Program: Improving public understanding of Documentary Heritage of Chosun Dynasty	
	<b>Museum of Art</b> , SNU	Spring 2011
	Docent	

Program: Improving public understanding of interactive media art in the Garden of Forking Paths

MILITARY SERVICE **Military Required Service**, South Korea

2007 – 2009

Honorably Discharged as a Sergeant

Served inter alia in Food/Water Inspectorate (Laboratory) plus assist. mgmt.

## References

Professor Rosalba Perna (Associate Department Chair)  
Department of Physics and Astronomy, Stony Brook University  
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Professor Julian Krolik  
Department of Physics and Astronomy, Johns Hopkins University  
Bloomberg Center for Physics and Astronomy,  
3400 N. Charles Street, Baltimore, MD 21218, USA  
Telephone: +1 (410) 664 7077  
Email: jhk@jhu.edu

Professor Tsvi Piran (Schwartzman Chair for Theoretical Physics)  
Racah Institute for Physics, The Hebrew University of Jerusalem  
Edmond J. Safra Campus, Jerusalem 9190401, Israel  
Telephone: +972 26584233  
Email: tsvi.piran@mail.huji.ac.il

## Publications

ads link: <https://ui.adsabs.harvard.edu/user/libraries/mbdD-GljSZ-nQ6a7LbzzQw>

### Books

36. **Ryu, T.**, Wever, T., *Tidal Disruption Events*, To appear in Chapter 5 in the review book *Black Holes in the Era of Gravitational Wave Astronomy*, ed. Arca Sedda, Bortolas, Spera, pub. Elsevier., arXiv: 2310.16879

### Submitted Articles

35. Liu, Z., **Ryu, T.**, Goodwin, A., Rau, A., Homan, D., Krumpe, M., Merloni, A., Grotova, I., Anderson, G., Malyali, A., Miller-Jones, J., *Rapid evolution of the recurrence time in the repeating partial tidal disruption event eRASST J045650.3-203750*, submitted to A&A (2023)
34. Vynatheya, P., **Ryu, T.**, Pakmor, R., de Mink, S., Perets, H., *Simulating the Tidal Disruption of Stars by Stellar-mass Black Holes Using Moving-mesh Hydrodynamics*, submitted to A&A (2023), arXiv: 2310.14852
33. **Ryu, T.**, Amaro Seoane, P., Taylor, A., Ohlmann, S., *Collisions of Red Giants in Galactic Nuclei*, submitted to MNRAS (2023), arXiv: 2307.07338  
★ selected as the research highlight of the month in November 2023 by the Max Planck Institute for Astrophysics (<https://www.mpa-garching.mpg.de/1085421/hl202309>)
32. Avara, M., Krolik, J., Campanelli, M., Noble, S., Bowen, D., **Ryu, T.**, *Accretion onto a Supermassive Black Hole Binary Before Merger*, submitted to ApJ (2023), arXiv:2305.18538

### Articles in Refereed Journals

31. **Ryu, T.**, McKernan, B., Ford, K.E.S., Cantiello, M., Graham, M.J., Stern, D, Leigh, N.W.C. *In-plane Tidal Disruption of Stars in Disks of Active Galactic Nuclei*, MNRAS, 527, 8103 (2024), arXiv: 2310.00610
30. **Ryu, T.**, de Mink, S., Farmer, R., Pakmor, R., Perna, R., Springel, V., *Close Encounters of Star-black Hole Binaries with Single Stars*, MNRAS, 527, 2734 (2024), arXiv:2307.03097
29. Dessart, L., **Ryu, T.**, Amaro Seoane, P., Taylor, A., *The Look of High-velocity Red-giant Star collisions*, accepted for publication in A&A (2023), arXiv: 2310.07036
28. Xin, C., H. Haiman, Z., Perna, R., Wang, Y., **Ryu, T.** *Tidal Peeling Events: Low-eccentricity Tidal Disruption of a Star by a Stellar-mass Black Hole*, accepted for publication in ApJ, Arxiv: 2303.12846
27. Bellinger, E., Caplan, M., **Ryu, T.**, Bollimpalli, D., Ball, W., Kühnel, F., Farmer, R., de Mink, S., Christensen-Dalsgaard, J, *Solar evolution models with a central black hole*, ApJ, 959, 113 (2023)



26. **Ryu, T.**, Krolik, J., Piran, T., Noble, S., Avara, M., *Shocks Power Tidal Disruption Events*, 957, 12 ApJ (2023), arXiv:2305.05333
25. **Ryu, T.**, Valli, R., Pakmor, R., Perna, R., de Mink, S., Springel, V., *Close Encounters of Black Hole-star Binaries with Stellar-mass Black Holes*, MNRAS 525, 5752 (2023), arXiv:2304.01792
24. Franchini, A., Bonetti, M., Lupi A., Miniutti, G., Bortolas, E., Giustini, M. , Dotti., M., Sesana, A., Arcodia, R., **Ryu, T.** *QPEs from Impacts between the Secondary and a Rigidly Precessing Accretion Disc in an EMRI System*, A&A, 675, 100 (2023), Arxiv: 2304.00775
23. Bortolas, E. , **Ryu, T.**, Broggi, L., Sesana, A. *Partial Stellar Tidal Disruption Events and Their Rates*, MNRAS, 524, 3026 (2023), Arxiv: 2211.02734
22. **Ryu, T.**, Perna, R., Parkmor, R., Ma, J., Farmer, R., de Mink, S. *Close Encounters of Tight Binary Stars with Stellar-mass Black Holes*, MNRAS, 519, 5787 (2023), arXiv: 2211.02734
21. **Ryu, T.**, Krolik, J., Piran, T. *Extremely Relativistic Tidal Disruption Events*, ApJL, 946, 33 (2023), arXiv: 2211.00059
20. **Ryu, T.**, Perna, R., Wang, Y. *Close Encounters of Stars with Stellar-mass Black Hole Binaries*, MNRAS, 516, 2204 (2022), arXiv: 2206.00603
19. **Ryu, T.**, Trani, A. A. , Leigh, N.W.C. *Tidal Disruption Events by Compact Supermassive Black Hole Binaries*, MNRAS, 515, 2430 (2022), arXiv: 2202.07668
18. McKernan, B., Ford, K.E.S., Cantiello, M., Graham, M.J., Jermyn, A.S., Leigh, N.W.C., **Ryu, T.**, Stern, D. *Starfall: A Heavy Rain of Stars in 'Turning on' AGN*, MNRAS, 514, 3 (2022), arXiv: 2110.03741
17. **Ryu, T.**, Krolik, J., Piran, T. *The Impact of Shocks on the Vertical Structure of Eccentric Disks*, ApJ, 920.2, 130, arXiv: 2105.09434 (2021)
16. **Ryu, T.**, Krolik, J., Piran, T. *Measuring Stellar and Black Hole Masses of Tidal Disruption Events*, ApJ, 904.1, 73 (2020), arXiv: 2007.13765
15. Krolik, J., Piran, T., **Ryu, T.** *Tidal Disruptions of Main Sequence Stars – V. The Varieties of Disruptions*, ApJ, 904.1, 68 (2020), arXiv: 2001.03234
14. **Ryu, T.**, Krolik, J., Piran, T., Noble, N. *Tidal Disruptions of Main Sequence Stars – IV. Relativistic Effects and Dependence on Black Hole Mass*, ApJ, 904.2, 101 (2020), arXiv: 2001.03504
13. **Ryu, T.**, Krolik, J., Piran, T., Noble, N. *Tidal Disruptions of Main Sequence Stars – III. Stellar Mass Dependence of the Character of Partial Disruptions*, ApJ, 904.2, 100 (2020), arXiv: 2001.03503
12. **Ryu, T.**, Krolik, J., Piran, T., Noble, N. *Tidal Disruptions of Main Sequence Stars – II. Simulation Methodology and Stellar Mass Dependence of the Character of Full Tidal Disruptions*, ApJ, 904.2, 99 (2020), arXiv: 2001.03502

11. **Ryu, T.**, Krolik, J., Piran, T., Noble, N. *Tidal Disruptions of Main Sequence Stars – I. Observable Quantities and their Dependence on Stellar and Black Hole Mass*, ApJ, 904.2, 98 (2020), arXiv: 2001.03501
10. **Ryu, T.**, Zingale, M., Perna, R. *Turbulence-driven Thermal and Kinetic Energy in the Atmospheres of Hot Jupiters*, MNRAS, 481, 5517 (2018)
9. Ibragimov, T., Leigh, N., W. C., **Ryu, T.**, Panurach, T., Perna, R. *When Do Star Clusters Become Multiple Star Systems? II. Toward a Half-life Formalism For Arbitrary Particle Masses*, MNRAS, 477, 4213 (2018)
8. **Ryu, T.**, Perna, R., Haiman, Z., Ostriker, J. P., Stone, N. C. *Interactions between Multiple Supermassive Black Holes in Galactic Nuclei: a Solution to the Final Parsec Problem*, MNRAS, 473, 3410 (2018)
7. Belczynski, K., **Ryu, T.**, Perna, R., Berti, E., Tanaka, T. L., Bulik, T. *On the Likelihood of Detecting Gravitational Waves from Population III Compact Object Binaries*, MNRAS, 471, 4702 (2017)
6. **Ryu, T.**, Leigh, N., W. C., Perna, R. *Formation of Runaway Stars in a Star-cluster Potential*, MNRAS, 470, 3049 (2017)
5. **Ryu, T.**, Leigh, N., W. C., Perna, R. *An Analytic Method for Identifying Dynamically-formed Runaway Stars*, MNRAS, 470, 2 (2017)
4. **Ryu, T.**, Leigh, N. W. C., Perna, R. *Numerical Study of the  $N = 4$  Binary-binary Scatterings in a Background Potential*, MNRAS, 467, 4447 (2017)
3. **Ryu, T.**, Tanaka, T. L., Perna, R., Haiman, Z. *Intermediate-mass Black Holes from Population III Remnants in the First Galactic Nuclei*, MNRAS, 460, 4122 (2016)
2. **Ryu, T.**, Tanaka, T. L., Perna, R. *Formation, Disruption and Energy Output of Population III X-ray Binaries*, MNRAS, 456, 223 (2016)

#### Articles in conference proceedings

1. **Ryu, T.**, Tanaka, T. L., Perna, R. *Population III X-Ray Binaries*, in “Frontier Research in Astrophysics – II”, Italy, (2016).