

Andrey Vayner

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RESEARCH INTERESTS High-Redshift Universe, Galaxy Formation & Evolution, Active Galactic Nuclei (AGN), Quasars, AGN Feedback, Adaptive Optics, High Contrast Imaging, Radio Interferometry.

EDUCATION Ph.D. Physics, 2015-2019
Advisor: Shelley A. Wright
Thesis: Quasar hosts unveiled by high angular resolution techniques
University of California, San Diego

M.Sc. Astronomy & Astrophysics, 2013-2015
Advisors: Paola Rodriguez-Hidalgo, Shelley A. Wright
Research projects: 1) Constraining the Causes of Dramatic Variability in Newly Emerged Quasar Outflows & 2) Multi-Wavelength Observations of Radio Loud AGN
University of Toronto, Ontario, Canada

H.B.Sc. high distinction Physics & Astronomy w/ Minor in Mathematics, 2009-2013
Advisor: Shelley A. Wright
Thesis: "Resolving Host Galaxies of $z\sim 2$ Quasars using Adaptive Optics and Integral Field Spectroscopy"
University of Toronto, Ontario, Canada

HONORS AND AWARDS ALMA ambassador, 2020
The Royal Astronomical Society of Canada Gold Medal, 2013
Dunlap Institute for Astronomy & Astrophysics Graduate Student Scholarship, 2013
Professor C.A Chant Scholarship for Astronomy, 2012
Natural Science and Engineering Research Council of Canada (NSERC) Undergraduate Student Research Award, 2012

RESEARCH EXPERIENCE *Postdoctoral Fellow* 2019-Present
Department of Physics and Astronomy, Johns Hopkins University

- JWST early release science.
- Near-infrared integral field spectroscopy of extremely red quasars, mapping the most extreme outflows detected in the distant Universe.
- ALMA observations of molecular outflows at $z\sim 2$.
- Using the Keck Cosmic Web Imager to map the circumgalactic medium around massive $z\sim 2$ galaxies to understand their subsequent evolution from cosmic noon to present day.

Graduate Student Researcher 2015-2019
Department of Physics, UC San Diego

- Using laser guide star adaptive optics observation in combination with integral field spectroscopy to resolve host galaxies of distant quasars, to study the co-evolution of supermassive black holes and the galaxies that harbour them.
- Constraining molecular gas reservoirs of distant quasar host galaxies through CO spectroscopy with Atacama Large Millimeter/Submillimeter Array (ALMA)

Graduate Student Researcher

2012-2015

Department of Astronomy & Astrophysics, University of Toronto

- Using high-resolution optical spectroscopy of high-redshifts quasars to monitor the origin and evolution of winds from the vicinity of the black hole.
- Multiwavelength observations of radio-loud quasars with VLA, HST, Chandra, Herschel, SDSS. Constructing sample for follow up observations with laser guide star adaptive optics and integral field spectroscopy.

Summer undergraduate research assistant

Summers 2012-2013

Dunlap Institute for Astronomy and Astrophysics, University of Toronto

- Resolving Host Galaxies of $z \sim 2$ Quasars using Adaptive Optics and Integral Field Spectroscopy
- Reduced and analyzed data from the Keck & Gemini telescopes. Wrote routines for PSF subtraction to disentangle the bright unresolved quasar emission from the faint underlying host galaxy.

**REFEREED
PUBLICATIONS**

Wylezalek, D. and **Vayner, A.** and Rupke, D. S. N. and Zakamska, N. L. and Veilleux, S. and Ishikawa, Y. and Bertemes, C. and Liu, W. and Barrera-Ballesteros, J. K. and Chen, Hsiao-Wen and Goulding, A. D. and Greene, J. E. and Hainline, K. N. and Lützgendorf, N. and Hamann, F. and Heckman, T. and Johnson, S. D. and Lutz, D. and Mainieri, V. and Maiolino, R. and Nesvadba, N. P. H. and Ogle, P. and Sturm, E., *First results from the JWST Early Release Science Program Q3D: Turbulent times in the life of a $z \sim 3$ extremely red quasar revealed by NIRSpec IFU*, 2022, ApJ, accepted. arXiv:2210.10074

Vayner A., Zakamska N., Wright S. A., Armus L., Murray N., Walth G., *Multi-phase outflows in high redshift quasar host galaxies*, 2021, ApJ, 923, 59

Vayner, A. and Wright, S. A. and Murray, N. and Armus, L. and Boehle, A. and Cosens, M. and Larkin, J. E. and Mieda, E. and Walth, G. *A Spatially-Resolved Survey of Distant Quasar Host Galaxies: I. Dynamics of galactic outflows*, 2021, ApJ, 919, 122

Vayner, A. and Zakamska, N. L. and Riffel, Rogemar A. and Alexandroff, R. and Cosens, M. and Hamann, F. and Perrotta, S. and Rupke, D. S. N. and Storchi Bergmann, T. and Veilleux, S. and Walth, G. and Wright, S. and Wylezalek, D. *Powerful winds in high-redshift obscured and red quasars*, 2021, MNRAS, 504, 4445

Ishikawa, Y. and Goulding, A. D. and Zakamska, N. L. and Hamann, F. and **Vayner, A.** and Veilleux, S. and Wylezalek, D. *X-ray analysis of SDSS J165202.60+172852.4, an obscured quasar with outflows at peak galaxy formation epoch*, 2021, MNRAS 502, 3769

Vayner, A. and Wright, S. A. and Murray, N. and Armus, L. and Boehle, A. and Cosens, M. and Larkin, J. E. and Mieda, E. and Walth, G. *A Spatially Resolved Survey of Distant Quasar Host Galaxies. II. Photoionization and Kinematics of the ISM*, 2021, ApJ, 910, 44

Lockhart, K. E. and Do, T. and Larkin, J. E. and Boehle, A. and Campbell, R. D. and Chappell, S. and Chu, D. and Ciurlo, A. and Cosens, M. and Fitzgerald, M. P. and Ghez, A. and Lu, J. R. and Lyke, J. E. and Mieda, E. and Rudy, A. R. and **Vayner, A.** and Walth, G. and Wright, S. A. “*Characterizing and Improving the Data Reduction Pipeline for the Keck OSIRIS Integral Field Spectrograph*”, 2018, AJ, 157, 75

Cosens, M. Wright, S. A., Mieda, E., Murray, N., Armus, L., Do, T., Larkin, J. E., Larson, K., Martinez, G., Walth, G., **Vayner, A.** “*Size-Luminosity Scaling Relations of Local and Distant Star Forming Regions*”, 2018, ApJ, 869, 11

Vayner, A., Wright, S. A., Murray, N., Armus, L., Larkin, J. E., Mieda, E. “*Galactic Scale Feedback Observed in the 3C 298 Quasar Host Galaxy*”, 2017, ApJ, 851, 126

Vayner, A., Wright, S. A., Do, T., Larkin, J., Armus, L., Gallagher, S. C. “*Providing stringent star formation rate limits of $z \sim 2$ QSO host galaxies at high angular resolution*”, 2016, ApJ, 821, 64

NON-REFEREED PUBLICATIONS

Ragland, S., Dupuy, T. J., Jolissaint, L., Wizinowich, P. L., Lu, J. R., van Dam, M. A., Berriman, G. B., Best, W., Gelino, C. R., Ghez, A. M., Liu, M. C., Mader, J. A., **Vayner A.**, Witzel, G., Wright, S. A. “*Status of point spread function determination for Keck adaptive optics*”, 2018, SPIE, 10703, 13

Vayner, A., Wright, S., Murray, N. W., Armus, L., Larkin, J. E. “*QUART: Quasar hosts Unveiled by high Angular Resolution Techniques*”, 2016, American Astronomical Society 228th Meeting, 400.02

Vayner, A., Wright, S., Do, T., & Larkin, J.E. “*Resolving Host Galaxies of $z=2$ Quasars Using Adaptive Optics and Integral Field Spectroscopy*”, poster, 2013, American Astronomical Society 221st Meeting, 339.30

Membership & Services

SOC, Space Telescope Science Institute, Large-Volume Spectroscopic Analyses of AGN and Star Forming Galaxies in the Era of JWST
 March 2022
 Astrocoffee event organizer, Johns Hopkins University Physics & Astronomy
 2020 - present
 Referee, The Astrophysical Journal, MNRAS, 2018 - present
 ALMA Ambassador 2020
 Thirty Meter Telescope (TMT) Infrared Imaging Spectrograph (IRIS)
 Science Team Junior Member 2018 - present
 Graduate Student Representative, Dunlap Institute Management Committee 2014
 American Astronomical Society, Junior member 2013 - Present

TEACHING & PUBLIC OUTREACH

University of California, San Diego
 Teaching Assistant PHYS 164: Observational Astrophysics Winter 2017, 2018
 Leading tutorials, marking, telescope observing sessions Fall 2018
 Professional Development Program, UC Santa Cruz Winter-Spring 2017

As part of the Professional Development Program, I attended the Institute for Scientist & Engineer Educators (ISEE) inquiry and design institute, where I led a team to design an inquiry-based activity for summer undergraduate researchers. Students

focused on the STEM practice of designing and carrying out investigations. The content of the two-day activity focused on statistics and signal to noise ratio calculation with an introduction to future astronomical observatories.

University of Toronto

Teaching Assistant AST101: The Sun and its Neighbours Fall 2013-2015
Leading tutorials, planetarium operator & marking

Teaching Assistant AST201: Stars and Galaxies Winter 2014
Leading tutorials, planetarium operator & marking

Teaching Assistant PMU199: Great Astronomical Issues Winter 2015
Assisting students with astronomical observations using remote telescopes

Free Monthly Astronomy Public Tours 2013-2015
Media Relations Director: overlook monthly advertisements, prepare posters and website graphics, communicate with advertisers and send monthly newsletters to the public.

Free Monthly Astronomy Public Tours 2012-2013
Telescope operator: 8", 10" and 16" telescope guide for public observing.

Sidewalk Astronomy Summers 2013 and 2014
Assisted in operating solar telescopes for observing sessions once a week during lunch hour in downtown Toronto.

Physics undergraduate mentoring program 2013-2014
Mentored senior undergraduate physics & astronomy student

Astronomy graduate student mentorship program 2015-2016
Organized and ran mentorship program for incoming astronomy graduate students

Student Supervision

Yuzo Ishikawa, 2019 - present, co-supervision with Prof. Nadia Zakamska, Johns Hopkins University
Sanchit Sabhlok, 2019 - present, co-supervision with Prof. Shelley Wright, UC San Diego

Telescope Proposals and Research Grants

Gemini North Observatory, PI, 2022B
Approved for 13 hours - *Extreme quasar feedback at the peak of the galaxy formation epoch*

W.M Keck Observatory (KCWI), NASA 22A - PI
1 night, \$17K - *Winds in the circumgalactic medium of extremely red quasars.*

James Webb Space Telescope, PI, Cycle 1
Approved for 21 hours - *Extreme quasar feedback at the peak of the galaxy formation epoch*

James Webb Space Telescope, CoI, Cycle 1
Approved for 24.6 hours - *Zooming into the monster's mouth: tracing feedback from their hosts to circumgalactic medium in z=3.5 radio-loud AGN*

James Webb Space Telescope, CoI, Cycle 1
Approved for 8.8 hours - *Quasar Feedback in Action: The Multiphase and Multiscale Outflow of the Most Luminous Quasar in the Local Universe*

NASA, Astrophysics Data Analysis Program, CoI, 2020
\$435K - *Feeding and feedback in the circumgalactic medium at the peak epoch of quasar activity.*

Gemini North Observatory, PI, 2020A
Approved for 3 hours - *Extreme quasar feedback at the peak of the galaxy formation epoch*

Atacama Large Millimeter/Submillimeter Array (ALMA), PI, Cycle 2
60.88 minutes observed - *Probing The Star Burst Phase of Quasar Host Galaxies*

Atacama Large Millimeter/Submillimeter Array (ALMA), PI, Cycle 3
79 minutes observed - *Unique high resolution & multi-wavelength study of a $z=1.4$ quasar host galaxy*

Atacama Large Millimeter/Submillimeter Array (ALMA), PI, Cycle 5
Approved for 18 hours (Grade B) - *Searching for feedback with 3D multi-phase interstellar medium study in $z\sim 2$ quasar host galaxies*

W.M Keck Observatory (OSIRIS-LGS), CoI [Ph.D. Thesis], 2015-2017
9.5 nights total - *Resolving Star Formation and Nebular Line Ratios in Host Galaxies of High-Redshift Quasars*

W.M Keck Observatory (KCWI), CoI [Ph.D. Thesis], 2017-2020
7.5 night - *Resolving distant quasar host galaxies and their environments*

Observing Experience

W.M Keck Observatory:
Keck I (OSIRIS-LGS/NGS): 17.0 nights
Keck II (NIRC2-LGS/NGS): 4.0 nights
Keck II (KCWI): 7 nights

Lick Observatory:
Nickel: 2 nights

Data Experience & Skills

Instrument Data reduction & Analysis:

W.M Keck Observatory: OSIRIS, NIRC2, LRIS, KCWI
Gemini: NIFS

ALMA: Experience reducing mm interferometric data with CASA

Chandra Space Observatory: CIAO, ChaRT, MARX

Extensive analysis of optical and near-infrared spectroscopic data. Experience with mid/far-infrared photometry and SEDs

Languages & Software:

Python, IDL, LaTeX

Working Groups:

Q3D software development for JWST integral field unit data analysis 2019 - present
OSIRIS data reduction pipeline team 2014-present
Keck PSF-R commissioning science team 2016-present

SEMINARS & INVITED TALKS California Institute of Technology Astronomy Tea Talk, May 2022, Pasadena, California, “*Gas Flows in Massive Galaxies at Cosmic Noon with Integral Field Spectroscopy.*”

University of Maryland, CTC Seminar, November 2021, College Park, Maryland “*Extremely red and obscured quasars with JWST integral field spectroscopy*”

Space Telescope Science Institute, JHU/STScI JWST Science Symposium, October 2021, Baltimore, Maryland “*Extremely red and obscured quasars with JWST integral field spectroscopy*”

Johns Hopkins University, Department Seminar, September 2019, Baltimore, Maryland “*Quasar host galaxies and their environments with multi-wavelength 3D spectroscopy*”

UC Irvine, Astronomy Seminar, October 2018, Irvine, California, “*Quasar host galaxies and their environments with multi-wavelength 3D spectroscopy*”

Carnegie Observatories, Lunch Talk, October 2018, Pasadena, California, “*Quasar host galaxies and their environments with multi-wavelength 3D spectroscopy*”

UC Berkeley, Lunch Talk, October 2018, Berkeley, California, “*Quasar hosts Unveiled by high Angular Resolution Techniques*”

UC Los Angeles, Astronomy Seminar, November 2017, Los Angeles, California, “*Quasar hosts Unveiled by high Angular Resolution Techniques*”

California Institute of Technology Astronomy Tea Talk, November 2017, Pasadena, California, “*Quasar hosts Unveiled by high Angular Resolution Techniques*”

CONFERENCE TALKS AND POSTERS Talk, Space Telescope Science Institute, Large-Volume Spectroscopic Analyses of AGN and Star Forming Galaxies in the Era of JWST, March 2022, Baltimore, Maryland “*Fitting rest-frame UV and optical IFS data with Q3Dfit for JWST*”

Talk, IAU Symposium 359: Galaxy Evolution and Feedback Across Different Environments (GALFEED), Bento Gonçalves, RS, Brazil “*Distant quasar host galaxies and their environments with multi-wavelength 3D spectroscopy*”

Talk, Center for Adaptive Optics Fall Retreat, November 2018, Lake Arrowhead, California, “*Challenges for flux calibrating AO-assisted integral field spectroscopy observations*”

Poster, Keck Science Meeting, 2018, Caltech, California, “*OSIRIS and KCWI reveal feeding and feedback in distant Quasar Host Galaxies*”

Talk, Center for Adaptive Optics Fall Retreat, October 2017, Lake Arrowhead, California, “*Quasar host galaxies and point spread function reconstruction*”

Talk, Keck Science Meeting, 2017, Santa Cruz, California, “*Quasar hosts Unveiled by high Angular Resolution Techniques (QUART)*”

Poster, Keck Science Meeting, 2016, Caltech, California, “*Resolving distant quasar host galaxies with high angular resolution techniques*”

Poster, Mapping the Pathways of Galaxy Transformation Across Time and Space, 2016, Catalina Island, California, “*Resolving distant quasar host galaxies with high angular resolution techniques*”

Talk, American Astronomical Society 228th Meeting, 2016, San Diego, California, “*QUART: Quasar hosts Unveiled by high Angular Resolution Techniques*”

Poster, Powerful AGN conference, 2014, Port Douglas, Queensland, Australia, “*Providing stringent star formation rate limits of $z \sim 2$ QSO host galaxies at high angular resolution*”

Talk, Canadian Astronomical Society Annual General Meeting, 2014, Quebec City, Quebec, Canada, “*Constraining the Causes of Dramatic Variability in Newly Emerged Quasar Outflows*”

Poster, American Astronomical Society 221st Meeting, 2013, Long Beach, California “*Resolving Host Galaxies of $z=2$ Quasars Using Adaptive Optics and Integral Field Spectroscopy*”

Media coverage JHU Hub, “Webb reveals unprecedented glimpse of merging galaxies”, October 20, 2022

European Space Agency (ESA), “Webb uncovers dense cosmic knot in the early Universe”, October 20, 2022

NASA, “NASA’s Webb Uncovers Dense Cosmic Knot in The Early Universe” October 20, 2022

Gizmodo, “Webb Telescope Finds Polychrome Quasar Surrounded by Ancient Galaxies” October 20, 2022

CNET, “NASA Webb Telescope Reveals Dramatic Galaxy Merger Around ‘Monster’ Black Hole” October 20, 2022

Newsweek magazine, “Supermassive black hole hiding at the heart of a galaxy changes the whole neighborhood”, December 21, 2017.

Engadget, “Supermassive black holes may control galaxy formation”, December 21, 2017

Big Island Now, “Study Suggests Black Holes can Control Galaxy Formation” December 24, 2017