

Curriculum Vitae

Tobias Karl Fritz
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Education and work

October 2013-present: Research Associate at the University of Virginia; I am working together with Professor Dr. Nitya Kallivayalil

July 2013- September 2013: Postdoc at Max-Planck Institute for Extraterrestrial Physics (MPE)

September 2009-July 2013: PhD thesis, grade: magna cum laude, Thesis advisors: Professor Dr. Reinhard Genzel, Dr. Stefan Gillessen, "*From the Sun to the Galactic Center: Dust, Stars and Black Hole(s)*"

March 2009-September 2009: Research Assistant at MPE

January 2008 – February 2009: Diploma thesis (similar to Master thesis) at MPE Garching, Germany; Thesis advisors: Professor Dr. Reinhard Genzel, Dr. Stefan Gillessen, "*Astrometry of IRS13E*"

October 2003 – March 2009: Physics studies for the degree of Diplom-Physik (similar to Msc+Bachelor in one degree in physics) at Ludwigs-Maximilians-University (LMU) Munich, Germany, grade: sehr gut (very good)

Observing proposals:

Proper motions of local group objects:

- **PI - Gemini South**, (2014B to 2018A), **Large Program 143.3 h**, "*Probing the dark halo of the Milky Way with GeMS/GSAOI*"
- **Co-I - HST-14734 (Cycle 24): 164 orbits**, "*Milky Way Cosmology: Laying the Foundation for Full 6-D Dynamical Mapping of the Nearby Universe*"
- **PI - LBT/LBC** (2016A), 5 hours, imaging for proper motions, "*The origin of Segue 1, one of the darkest galaxies*"
- **Co-I - HST-14236 (Cycle 23): 14 orbits**, "*The First Proper Motions of Ultra-faint Dwarf Galaxies: Probing Reionization and Planar Associations of Satellites*"
- **Co-I - LBT/LBC** (2014A), 12 hours, "*Astrometry of the Palomar 5 stream*"
- **Co-I - HST-13834 (Cycle 22): 22 orbits**, "*The Proper Motion field along the Magellanic Bridge: a New Probe of the LMC-SMC interaction*"
- **PI - LBT/LBC** (2016B/2017A), 9 hours, imaging for proper motions, "*The orbit of Crater II, the feeble giant*"

Revealing the complexity of the Galactic Center:

- **PI – VLT/SINFONI/NACO**, (2011 to 2013), 51 hours, Preimaging for candidate selection and second for proper motions, integral field spectroscopy, “*What is the origin of young stars in the Galactic Center?*”
- **PI - Herschel space observatory/PACS** (2012), 40.1 hours, imaging for time variability, “*Discovering Sgr A* in the far infrared with Herschel*”
- **Co-I - Keck/NIRSPEC** (2015A to 2017A): 7 half nights, “*High Resolution Infrared Spectroscopy of Giants in the Nuclear Bulge/Cluster*”
- **Co-I – VLT/XSHOOTER**, (2017), 2 nights, “*Chemical tagging of the Milky Way nuclear cluster*”
- **Co-I - VLT/NACO+APEX/LABOCA**, (2011), 99 hours, “*What is the Origin of the Flares of Sgr A*?*”
- **PI - Herschel space observatory/PACS** (2012), 6.7 hours, H recombination line integral field spectroscopy, “*Extinction towards the Galactic Center*”
- **Co-I - VLT/NACO+SINFONI** (2013-2014) 53.5 hours, “*Watching a gas cloud fall into the super-massive black hole in the Galactic Center*”
- **Co-I - VLT/NACO+SINFONI** (2012-2014), 54 hours, “*Stellar dynamics in the central arcsecond around the Massive Black Hole in the Galactic Center*”

The outer halo of the Milky Way:

- **PI - LBT/MODS** (2015A/B), 14 hours, spectroscopy, “*Probing the Outer Halo of the Milky Way with M-giants*”
- **Co-I - LBT/MODS** (2014B), 8 hours, “*Probing the Outer Halo of the Milky Way with M-giants*”

Abilities

Languages

German: Native Speaker

English: Professional Proficiency

Observational experience

- **2015-2017**: 19 nights of observations with **Gemini South**, using the 5 Laser AO camera system GeMS/GSAOI
- **2009-2013**: 33 half nights of observations with the **VLT** in the IR (1.1 to 4 microns), observations of the Galactic Centre, mostly with adaptive optics, sometimes also with Laser guide star; instruments used: the integral field spectrograph SINFONI, NACO in imaging mode

IT knowledge

Operating systems: Linux, Windows

Programming languages: IDL, dpuser (at MPE developed script languages, mainly for image reduction and analysis, also useful for many other purposes), some python

Word processing: Latex, Microsoft Office

Image visualization: ds9, QFitsView (At MPE developed Fits file viewer, which is optimized for integral field spectrograph data, includes dpuser)

Plotting: pgplot (part of dpuser)

Image/spectra analysis: dpuser, QFitsView, starfinder (a program for point spread function extraction and source extraction, optimized for adaptive optics images), GALFIT
Astronomical data reduction: SPREDUCE (data reduction software for SINFONI based on eclipse and python), dpuser, some IRAF, HIPE (Herschel-PACS data reduction)

Professional contributions

- **Referee** of 5 papers in total, for Earth, Planets and Space, MNRAS, AJ, ApJ, and ApJ letters in the scientific areas of Galactic Center, proper motions, dwarf galaxies and extinction modeling
- Regular presentations of **recent papers** in astro-ph discussions (Voxcharta) at University of Virginia

Conferences and Colloquia

Conference, contributed talks

- **April 2017**, Astronomy and astrophysics in the Gaia sky (Nice, France), “*Using ground based data as precursor for Gaia for getting proper motions of satellites*”
- **March 2017**, NRAO postdoctoral symposium (Charlottesville, Virginia, USA), “*Using proper motions to constrain Milky Way properties and the origin of its satellites*”
- **October 2015**, AO4ELT4 (Lake Arrowhead, California, USA), “*Astrometry with MCAO at Gemini and ELTs*”
- **June 2015**, Future & Science of Gemini Observatory (Toronto, Ontario, Canada), “*Probing the dark halo of the Milky Way with GeMS/GSAOI*”
- **September 2013**, IAU symposium 303; The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus (Santa Fe, New Mexico, USA), “*The Nuclear Cluster of the Milky Way*”
- **March 2013**, Gas Dynamics and Star Formation in the Extreme Environment of Galactic Nuclei (Ringberg, Germany), “*The Nuclear Cluster of the Milky Way*”
- **December 2012**, Gluehwein Aarseth N-body meeting (Bonn, Germany), “*The smallest and the biggest star cluster*”
- **September 2011**, The Central Kiloparsec in Galactic Nuclei, Astronomy at High Angular Resolution 2011 (Bad Honnef, Germany), “*The extinction towards the galactic center and a new determination of the distance to the Galactic Center*”
- **June 2010**, Central Massive Objects: The Stellar Nuclei – Black Hole Connection, (ESO, Garching, Germany), “*GC-IRS13E – A puzzling association of three early-type stars*”
- **February 2010**, Probing Strong Gravity near Black Holes (Prague, Czech Republic), “*The prospects of probing relativity in the Galactic Center with Adaptive Optics Observations*”

Conference, poster

- **August 2014**, 11th Potsdam Thinkshop: Satellite galaxies and dwarfs in the local group (Potsdam, Germany) “*The absolute proper motion of Palomar 5*”

Colloquia and Invited talks

- 20 December 2016, Lund University (Lund, Schweden) “*Constraining halo and satellite properties with proper motions*”
- 8 December 2016, University of California Los Angeles (Los Angeles, USA) “*Origin and distance of the nuclear cluster*”
- 13 January 2015, AURA (La Serena, Chile) “*Masses and Proper Motions from the Galactic*

Center to Carina“

- 13 August 2012, ESO-Santiago (Santiago, Chile) „*The extinction curve towards the Galactic Center“*
- 13 July 2011, Universidad Catolica (Santiago, Chile) “*The extinction curve towards the Galactic Center”*

Other talks

- 2 May 2017, INAF – Observatorio Astronomico di Bologna (Bologna, Italy) “*Using proper motions to constrain Milky Way properties and the origin of its satellites”*
- 3 November 2016, Columbia University (New York, USA) ”*Constraining halo and satellite properties with proper motions“*
- 28 October 2016, Space Telescope Science Institute (Baltimore, USA) “*Constraining halo and satellite properties with proper motions“*
- 29 September 2016, Leibniz Institut fuer Astrophysik (Potsdam, Germany) “*Constraining halo and satellite properties with proper motions“*
- 23 September 2016, Institute of Astronomy (Cambridge, United Kingdom) “*Constraining halo and satellite properties with proper motions“*
- 15 September 2016, MPIA (Heidelberg, Germany) “*Constraining halo and satellite properties with proper motions“*
- 18 December 2015, MPE (Garching, Germany), “*Proper motions outside of the Galactic Center“*
- 10 September 2015 Laboratoire d'Astrophysique de Marseille (Marseille, France) “*Astrometry with GeMS/GSAOI“*
- 14 August 2014, MPIA (Heidelberg, Germany) “*The proper motion of Palomar 5“*
- 11 August 2014, MPE (Garching, Germany) ”*Proper motions in the halo of the Milky Way“*

Educational contributions

- **Advising of students** in research for research projects: I was main adviser for 3 undergraduate students; the work of the most recent one, Martine Lokken, will lead to the publication on Segue 1. For the Pyxis project I also worked together with 3 graduate students (Dylan Angell, Sean Linden, Paul Zivick). With the latter two I continue to work together on other projects.
- **Teaching** of 3 lectures, 1 developed by myself. Introduction to astronomy for non major and to summer students
- **Outreach:** I helped at two Science days (Tag der offenen Tür) at MPE in Garching especially with the IR camera station. I contributed by public lectures in four **public nights** at Fan Mountain and McCormick Observatory in Virginia. I contributed to the **web feature** on the Pyxis paper.

Publication List of Tobias Fritz

9 first and second author publications:

- **Fritz, T. K.**, Linden, S., Zivick, P., Kallivayalil, N., Beaton, R., Bovy, J., Sales, L., Sohn, T., Angell, D., Boylan-Kolchin, M., Carrasco, E. R., Damke, G., Davies, R., Majewski, S., Neichel, B., van der Marel, R.
2017, ApJ, 840, 30
The proper motion of Pyxis: the first use of adaptive optics in tandem with HST on a faint halo object
Gemini made a **web feature** on it: <http://www.gemini.edu/node/1266>
- **Fritz, T. K.**, Kallivayalil, N.
2015, ApJ, 453, 939
The proper motion of Palomar 5
- **Fritz, T. K.**, Chatzopoulos, S., Gerhard, O., Gillessen, S., Genzel, R., Pfuhl, O., Tacchella, S., Eisenhauer, F., Ott, T.
2016, ApJ, 821, 44
The nuclear cluster of the Milky Way: total mass and luminosity
- **Fritz, T. K.**, Gillessen, S., Dodds-Eden, K., Lutz, D., Genzel, R., Raab, W., Ott, T., Pfuhl, O., Eisenhauer, F., Yusef-Zadeh, F.
2011, ApJ, 737, 73
Line derived infrared extinction toward the Galactic center
- **Fritz, T. K.**, Gillessen, S., Dodds-Eden, K., Martins, F., Bartko, H., Genzel, R., Paumard, T., Ott, T., Pfuhl, O., Trippe, S., Eisenhauer, F., Gratadour, D.
2010, ApJ, 721, 395
GC-IRS13E- A puzzling association of three early-type stars
- **Fritz, T.**, Gillessen, S., Trippe, S., Ott, T., Bartko, H., Pfuhl, O., Dodds-Eden, K., Davies, R., Eisenhauer, F., Genzel, R.
2010, MNRAS, 401, 1177
What is limiting near infrared astrometry in the Galactic centre?
- Ryde, N., **Fritz, T. K.**, Rich, R. M., Thorsbro, B., Schultheis, M., Origila, L., Chatzopoulos, S.
2016, ApJ, 831, 40
Detailed Abundance Analysis of a Metal-poor Giant in the Galactic Center
- Pfuhl, O., **Fritz, T. K.**, Zilka, M., Maness, H., Eisenhauer, F., Genzel, R., Gillessen, S.; Ott, T., Dodds-Eden, K., Sternberg, A.
2012, ApJ, 741, 108,
The star formation history of the Milky Way's nuclear star cluster
- Chatzopoulos, S., **Fritz, T. K.**, Gerhard, O., Gillessen, S., Wegg, C., Genzel, R., Pfuhl, O.
2015, MNRAS, 447, 948

The old nuclear star cluster in the Milky Way: dynamics, mass, statistical parallax, and black hole mass

PhD Thesis

- **Fritz, Tobias**
2013, Ludwig-Maximilians-University, Munich
From the sun to the Galactic Center: dust, stars and black hole(s)

2 first author conference proceedings:

- **Fritz, T. K.**, Kallivayalil, N., Carrasco, E. R., Neichel, B., Davies, R., Beaton, R., Angell, D., Linden, S., Zivick, P., Majewski, S., Damke, G., Boylan-Kolchin, M., van der Marel, R., Sohn, T.
2015, arXiv:1601.00965, Proceedings of Adaptive Optics for Extremely Large Telescopes 4, *Astrometry with MCAO at Gemini and at ELTs*
- **Fritz, T. K.**, Chatzopoulos, S., Gerhard, O., Gillessen, S., Genzel, R., Pfuhl, O., Tacchella, S., Eisenhauer, F., Ott, T.
2014, IAU Symposium, 202, 248
The nuclear cluster of the Milky Way: total mass and luminosity

2 manuscripts in preparation:

- **Fritz, T. K.**, Lokken, M., Kallivayalil, N., Wetzel, A. R., Linden, S., Zivick, P.
probably ApJ
The Orbit and Origin of the Ultra-faint Dwarf Galaxy Segue 1
- **Fritz, T. K.**, Kallivayalil, N., Linden, S., Zivick, P., Bovy, J.
2017, IAU Symposium, 330
Using ground based data as precursor for Gaia for getting proper motions of satellites

18 refereed coauthor publications:

- Bovy, J., Bahmanyar, A., **Fritz, T. K.**, Kallivayalil, N.
2016, ApJ, 833, 31
The shape of the inner Milky Way halo from observations of the Pal 5 and GD-1 stellar streams
- Gillessen, S., Genzel, R., **Fritz, T. K.**, Quatert, E., Alig, C., Burkert, A., Cuadra, J., Eisenhauer, F., Pfuhl, O., Dodds-Eden, K., Gammie, C. F., Ott, T.
2012, **Nature**, 481, 7379,
A gas cloud on its way towards the supermassive black hole at the Galactic Centre
ESO made a **press release** on it: <https://www.eso.org/public/unitedkingdom/news/eso1151/>
- Dodds-Eden, K., Gillessen, S., **Fritz, T. K.**, Eisenhauer, F., Trippe, S., Genzel, R., Ott, T., Bartko, H., Pfuhl, O., Bower, G., Goldwurm, A., Porquet, D., Trap, G., Yusef-Zadeh, F.
2011, ApJ, 728, 37
The two states of Sgr A in the near-infrared: bright episodic flares on top of low-level*

continuous variability

- Gillessen, S., Eisenhauer, F., **Fritz, T. K.**, Bartko, H., Dodds-Eden, K., Pfuhl, O., Ott, T., Genzel, R.
2009, ApJL, 707, 114
The orbit of the star S2 around Sgr A from Very Large Telescope and Keck data*
- Chatzopoulos, S., Gerhard, O., **Fritz, T.**, Wegg, C., Gillessen, S.
2015, MNRAS, 453, 939
Dust within the old nuclear star cluster in the Milky Way
- Schultheis, M., Cunha, K., Zasowski, G., Garcia Perez, A. E., Sellgren, K., Smith, V., Garcia-Hernandez, D. A., Zamora, O., **Fritz, T. K.**, Anders, F., Allende Prieto, C., Bizyaev, D., Kinemuchi, K., Pan, K., Malanushenko, E. Malanushenko, V., Shetrone, M. D.
2015, A&A, 45, 5
Evidence for a metal-poor population in the inner Galactic bulge
- Pfuhl, O., Gillessen, S., Eisenhauer, F., Genzel, R., Plewa, P. M., Ott, T., Ballone, A., Schartmann, M., Burkert, A., **Fritz, T. K.**, Sari, R., Steinberg, E., Madigan, A.-M.
2014, ApJ, 798, 111
The Galactic Center Cloud G2 and its Gas Streamer
- Pfuhl, O., Alexander, T., Gillessen, S., Martins, F., Genzel, R., Eisenhauer, F., **Fritz, T. K.**, Ott, T.
2014, ApJ, 782, 101
*Massive Binaries in the Vicinity of Sgr A**
- Gillessen, S., Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T., Schartmann, M., Ballone, A., Burkert, A.
2013, ApJ, 774, 44
Pericenter Passage of the Gas Cloud G2 in the Galactic Center
- Gillessen, S., Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T., Cuadra, J., Schartmann, M., Burkert, A.
2013, ApJ, 763, 78
New observations of the gas cloud G2 in the Galactic center
- Ballone, A., Schartmann, M., Burkert, A., Gillessen, S., Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T.
2013, ApJ, 776, 13
Hydrodynamical Simulations of a Compact Source Scenario for the Galactic Center Cloud G2
- Burkert, A., Schartmann, M., Alig, C., Gillessen, S., Genzel, R., **Fritz, T. K.**, Eisenhauer, F.
2012, ApJ, 750, 58
Physics of the Galactic center cloud G2, on its way toward the supermassive black hole
- Schartmann, M., Burkert, A., Alig, C., Gillessen, S., Genzel, R., Eisenhauer, F., **Fritz, T. K.**
2012, ApJ, 755, 155

Simulations of the origin and fate of the Galactic center cloud G2

- Bartko, H., Martins, F., Trippe, S., **Fritz, T. K.**, Genzel, R., Ott, T., Eisenhauer, F., Gillessen, S., Paumard, T., Alexander, T., Dodd-Eden, K., Gerhard, O., Levin, Y., Mascetti, L., Nayakshin, S., Perets, H. B., Perrin, G., Pfuhl, O., Reid, M. J., Rouan D., Zilkam M., Sternberg, A.
2010, ApJ, 708, 834
An extremely top-heavy initial mass function in the Galactic center stellar disks
- Trippe, S., Davies, R., Eisenhauer, F., Förster Schreiber, N. M., **Fritz, T. K.**; Genzel, R.
2010, MNRAS, 402, 1126
High-precision astrometry with MICADO at the European extremely large telescope
- Dodds-Eden, K., Porquet, D., Trap, G., Quataert, E., Haubois, X., Gillessen, S., Grosso, N., Pantin, E., Falcke, H., Rouan, D., Genzel, R., Hasinger, G., Goldwurm, A., Yusef-Zadeh, F., Clenet, Y., Trippe, S., Lagage, P.-O., Bartko, H., Eisenhauer, F., Ott, T., Paumard, T., Perrin, G., Yuan, F., **Fritz, T. K.**, Mascetti, L.
2009, ApJ, 698, 676,
Evidence for X-Ray synchrotron emission from simultaneous mid-infrared to X-Ray observations of a strong Sgr A flare*
- Bartko, H., Martins, F., **Fritz, T. K.**, Genzel, R., Levin, Y., Perets, H. B., Paumard, T., Nayakshin, S., Gerhard, O., Alexander, T., Dodds-Eden, K., Eisenhauer, F., Gillessen, S., Mascetti, L., Ott, T., Perrin, G., Pfuhl, O., Reid, M. J., Rouan, D., Sternberg, A., Trippe, S.
2009, ApJ, 697, 1714,
Evidence for warped disks of young stars in the Galactic center
- Trippe, S., Gillessen, S., Gerhard, O. E., Bartko, H., **Fritz, T. K.**, Maness, H. L., Eisenhauer, F., Martins, F., Ott, T., Dodds-Eden, K., Genzel, R.
2008, A&A, 492, 419,
Kinematics of the old stellar population at the Galactic centre

11 coauthor conference proceedings:

- Bochanski, J. J., Willman, B., Caldwell, N., Sanderson, R. E., West, A. A., Strader, J., Brown, W. R., **Fritz, T.**, Kallivayalil, N.
2015, AAS meeting #225, 342, 19
Hunting the Most Distant Stars in the Milky Way
- Schartmann, M., Burkert, A., Ballone, A., Alig, C., Gillessen, S., Genzel, R., Eisenhauer, F., **Fritz, T.**
2014, IAU Symposium, 303, 342
Hydrodynamical simulations of G2 interpreted as a diffuse gas cloud
- Ballone, A., Schartmann, M., Burkert, A., Gillessen, S., Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T.
2014, IAU Symposium, 303, 307
Hydrodynamical simulations of a compact source scenario for G2

- Gillessen, S. Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T., Burkert, A., Schartmann, M., Ballone, A.
2014, IAU Symposium, 303, 254
Observations of the gas cloud G2 in the Galactic center
- Gillessen, S., Eisenhauer, F., **Fritz, T. K.**, Pfuhl, O., Ott, T., Genzel, R.
2013, IAU Symposium, 289, 29
The distance to the Galactic Center
- Schartmann, M., Burkert, A., Alig, C., Gillessen, S., Genzel, R., Eisenhauer, F., **Fritz, T.** Ballone, A.
2012, Proceedings of Nuclei of Seyfert galaxies and QSOs - Central engine & conditions of star formation (Seyfert 2012), 5, 5
Simulations of the origin and fate of the Galactic Center cloud G2
- Dodds-Eden, K., Porquet, D., Trap, G., Quataert, E., Gillessen, S., Grosso, N., Genzel, R., Goldwurm, A., Yusef-Zadeh, F., Trippe, S., Bartko, H., Eisenhauer, F., Ott, T., **Fritz, T.**, Pfuhl, O.
2011, ASPC, 439, 309
Flares from Sgr A and their emission mechanism*
- Trippe, S., Gillessen, S., Gerhard, O. E., Bartko, H., **Fritz, T. K.**, Eisenhauer, F., Ott, T., Dodds-Eden, K., Genzel, R., Maness, H. L., Martins, F.
2011, ASPC, 439, 232
Kinematics of the old stellar population at the Galactic centre
- Gillessen, S., Eisenhauer, F., Bartko, H., Dodds-Eden, K., **Fritz, T. K.**, Pfuhl, O., Ott, T., Genzel, R.
2011, ASPC, 439, 157
The power of monitoring stellar orbits
- Bartko, H., Martins, F., Trippe, S., **Fritz, T. K.**, Genzel, R., Ott, T., Eisenhauer, F., Gillessen, S., Paumard, T., Alexander, T., Dodds-Eden, K., Gerhard, O., Levin, Y., Mascetti, L., Nayakshin, S., Perets, H. B., Perrin, G., Pfuhl, O., Reid, M. J., Rouan, D., Zilka, M., Sternberg, A.
2011, ASPC, 439, 100
Massive young stars in the Galactic center
- Bartko, H., Eisenhauer, F., **Fritz, T.**, Genzel, R., Gillessen, S., Martins, F., Ott, T., Paumard, T., Pfuhl, O., Trippe, S.
2008, JPhCS, 131, 2010
Young stars in the galactic center: one or two disks?

2 other Coauthor publications:

- Kallivayalil, N., Wetzel, A. R., Simon, J. D., Boylan-Kolchin, M., Deason, A. J., **Fritz, T. K.**, Geha, M., Sohn, S. T., Weisz, D. R.
2015, ArXiv:1503.01785

White Paper submitted for Hubble's 2020 Vision

A Hubble Astrometry Initiative: Laying the Foundation for the Next-Generation Proper-Motion Survey of the Local Group

- Walsh, J., Gillessen, S. , Genzel, R., **Fritz, T. K.**, Eisenhauer, F., Pfuhl, O., Ott, T., Schartmann, M., Ballone, A., Burkert, A., Hau, G., Girard, J., O'Neal, J., Bonnet, H.
2013, *The Messenger*, 153, 25
Following the G2 Gas Cloud towards the Galactic Centre