

## Prof. Dr. Katja Poppenhaeger

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RESEARCH  
INTERESTS      Formation and evolution of exoplanets and stars  
                  Stellar magnetic activity and gyrochronology  
                  Exoplanetary atmospheres and habitability

EDUCATION      **Hamburg University**, Germany, PhD in Astrophysics      2011/05  
                  Thesis: “Magnetic activity of planet-hosting stars”, advisor:  
                  J.H.M.M. Schmitt

**Goethe University Frankfurt**, Germany, MSc. in Physics      2004/02  
                  Thesis: “The Casimir effect in space-times with compactified extra  
                  dimensions”, advisor: H. Stöcker

APPOINTMENTS    **Leibniz Institute for Astrophysics & University Potsdam**, Germany  
                  Professor for Stellar Physics and Exoplanets      since 2018  
  
                  **Queen's University Belfast**, UK  
                  Visiting Research Professor in Astrophysics      since 2018  
                  Lecturer (Assistant Professor) in Astrophysics. Tenured March  
                  2018. Parental leave July - Nov. 2016.

**Harvard-Smithsonian Center for Astrophysics**, Cambridge, USA  
                  Sagan Postdoctoral Prize Fellowship      2013 - 2015  
                  Postdoctoral Fellow in the group of S.J. Wolk      2012 - 2013

**Hamburg Observatory**, Germany  
                  Postdoctoral Fellow in the group of J.H.M.M.Schmitt      2011 - 2012

**Environmental Protection Encouragement Agency**, Hamburg, Germany  
                  Scientist and project manager; led team of scientists and designers      2005 - 2007  
                  working on eco-effective product development

PUBLICATIONS    44 publications in peer-reviewed international journals to date (including 13  
                  first-author publications); 1 invited review, 1 entry in Astrophysics Source Code  
                  Library. Full list of publications at the end of this CV.  
                  Total citations: 919; h-index: 15 (as of December 2018).

HONORS & AWARDS	Leibniz Competition <i>Professorinnenprogramm</i> , awarded project “Combined evolution of star-exoplanet systems”	2019 - 2023
	Sagan Prize Fellowship, project “Understanding exoplanet systems through high-energy observations”	2013 - 2016
	Merit fellowship of <i>Studienstiftung des deutschen Volkes</i> (German National Academic Foundation; selects ca. 0.5% of the German students for sponsorship)	2001 - 2004

FUNDING Total external research funding: ca. USD 1 870 000 as Principal Investigator.

Grant	Year	Involvement	Value
Leibniz Competition	2019 - 2024	science PI	EUR 958 113
STFC PATT grant	2018 - 2020	PI	GBP 35 000
STFC consolidated grant	2017 - 2019	Co-I*	GBP 189 715
Chandra GO, Cycle 18	2017 - 2019	science PI	USD 24 600
STFC PATT grant	2016 - 2018	PI	GBP 47 000
Chandra GO, Cycle 17	2016 - 2018	science PI	USD 19 649
Chandra GO, Cycle 17	2016 - 2018	science PI	USD 16 948
HST GO, Cycle 23	2015 - 2017	science PI	USD 18 000
Chandra GO, Cycle 16	2014 - 2016	PI	USD 65 466
NASA ADAP, round 2013	2014 - 2016	PI	USD 74 021
Chandra DDT, Cycle 15	2014 - 2016	PI	USD 16 000
Chandra GO, Cycle 15	2013 - 2015	PI	USD 80 454
HST GO, Cycle 21	2013 - 2015	funding PI	USD 33 719
NASA Sagan Fellowship	2013 - 2016	PI	USD 247 500

\* Only Co-I share listed; full grant volume 2.3 M GBP.

GRANTED OBSERVING TIME	Total: > 350 h as PI, additional > 200 h as Co-I, using photometry and spectroscopy with space-based and ground-based instrumentation.	
	Successful observing programs in <ul style="list-style-type: none"> <li>- X-rays (XMM-Newton, Chandra, Swift)</li> <li>- UV (HST)</li> <li>- optical (VLT, Calar Alto, MMT and others)</li> <li>- IR (Spitzer)</li> <li>- Radio (VLA)</li> </ul>	

MANAGEMENT EXPERIENCE	Head of the research section “Stellar Physics and Exoplanets” at Leibniz Institute for Astrophysics Potsdam, including 3 senior scientists, ca. 5 postdoctoral researchers, ca. 8 PhD students	since 2018
	One of five organizers of 3-month research program “Better Stars, Better Planets: Exploiting the Stellar-Exoplanetary Synergy” at KITP Santa Barbara, USA ( <a href="https://www.kitp.ucsb.edu/activities/exostar19">https://www.kitp.ucsb.edu/activities/exostar19</a> )	2019/04 - 06
	Member of the Board of Governors of Armagh Observatory and Planetarium, Northern Ireland	2018
	Administrator and PI of institute-wide travel grant for telescope observing runs at Queen’s University Belfast	2016 - 2018

SUPERVISED STUDENTS AND STAFF	PhD student Nikoleta Ilic Petkovic; project “Stellar magnetic activity”, University of Potsdam/AIP PhD student Ekaterina Ilin; project “Flares in young stellar clusters and exoplanet systems”, University of Potsdam/AIP PhD student Robert Wells; project “Transiting exoplanets with Kepler-K2”, hosted at Queen’s University Belfast PhD student Rachel Booth; project “Ages of star-exoplanet systems”, hosted at Queen’s University Belfast Postdoc Rakesh Yadav; projects on stellar and planetary magnetic dynamos, magnetic activity of planet-hosting stars, hosted at CfA Several undergraduate students at Queen’s University Belfast and Harvard-Smithsonian Center for Astrophysics	since 2019/02 since 2018/11 since 2016/10 since 2015/11 2015 2013 - 2018
TEACHING	Lecture course “Astrophysics II (PHY3003)” at Queen’s University Belfast, 4 h per week Lecture + computer lab course “Computational projects in physics (PHY3009)” at Queen’s University Belfast, 4 h per week Lecture + computer lab course “Computational modelling in physics (PHY1003)” at Queen’s University Belfast, 4 h per week Lecture + computer lab course “Computational modelling in physics (PHY1024)” at Queen’s University Belfast, 7 h per week Completed Postgraduate Certificate in Higher Education Teaching (PGCHET) at Queen’s University Belfast	2018 2017 2017 2016 2017
COLLABORATIONS	Collaborator and Exoplanet Science Lead of NASA MIDEX Mission <b>Arcus</b> , a high-resolution X-ray space telescope for soft X-rays, PI Randall Smith (CfA); 2 M\$ concept study funding granted by NASA in 2017 Membership in Science Working Groups of accepted or to be proposed missions: <b>PLATO</b> WP 115-100 “Astrophysical noise sources and their impact on RV determination”; <b>Athena</b> SWG 3.1 “Solar System and Exoplanets”; <b>LynX</b> , to be proposed to NASA as a large-scale X-ray mission, groups “Stellar Life”, “Solar System and Exoplanets”, and “Stellar Birth” Science analysis team member of <b>YSOVAR</b> (Young Stellar Object VARIability), a large Spitzer Exploration Science program to study the variability of young stars and protoplanetary disks through infrared observations ( <a href="http://ysovar.ipac.caltech.edu">http://ysovar.ipac.caltech.edu</a> )	since 2014     since 2012

PROFESSIONAL ACTIVITIES	<i>Department service:</i>	
	Developed, organized and delivered interactive workshop on “Unconscious Bias in Academia” at Queen’s University Belfast, also held workshop at other universities and conferences upon invitation	since 2016
	Member of “Athena SWAN” committee (UK gender equality scheme for academia) at the School of Mathematics & Physics, Queen’s University Belfast	2015 - 2018
	Organizer of “Women in Science Chats” at Harvard-Smithsonian Center for Astrophysics (Career Q&A meetings of female postdocs and graduate students with visiting scientists)	2012 - 2015
	Member of the Postdoc Council at the Harvard-Smithsonian Center for Astrophysics	2012 - 2013
	<i>Reviewing &amp; Refereeing:</i>	
	Journal referee for <i>The Astrophysical Journal, MNRAS, New Astronomy</i>	since 2011
	External Reviewer for STFC Astronomy Grants	2017
	Reviewer for NSF Astronomy & Astrophysics Grants Panel	2015
	Reviewer for NASA fellowship programs (graduate student and postdoctoral level)	since 2014
	External reviewer for OPTICON Time Allocation Committee	2012
	Reviewer for Chandra Cycle 13 Time Allocation Committee	2011
	<i>Conference organizing:</i>	
	Science Organizing Committee member of international conference “The X-ray Universe”, Rome, Italy	2017
	Science Organizing Committee member of international conference “Radio exploration of planetary habitability”, Arecibo, Puerto Rico	2017
	Co-organizer of splinter session “Upgrading the solar-stellar pathway: news about activity in cool stars” (18th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, Flagstaff, USA)	2014
	Organizer of splinter session “Nonthermal processes in coronae and beyond”, 17th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, Barcelona, Spain	2012
	One of four organizers of the Postdoc Symposium 2012 at the Harvard-Smithsonian Center for Astrophysics	2012
	Co-organizer of splinter session “Frontiers in X-ray astronomy” (16th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, Seattle, USA)	2010

PUBLIC OUTREACH	Invited public lecture for the Irish Astronomical Association, “Exotic worlds: planets in other solar systems and what they might look like”, Belfast (UK)	2017/03
	TEDx talk “Exploring space and exoplanets”, TEDx Conference Klagenfurth, Austria	2016/09
	Contributor to the <i>Chandra X-ray Observatory Blog</i> and the <i>Women In Astronomy Blog</i>	since 2013
	Popular science talks about research results in astronomy at Open Nights and other events	since 2011
CONFERENCES & TALKS	<i>Invited talks at international conferences:</i>	
	“How planets affect cool stars”, Cool Stars 20 conference, Boston, USA	2018/07
	“How stars and planets interact: a look through the high-energy window”, XMM-Newton 2018 Science Workshop, Madrid, Spain	2018/06
	“Stellar ages as the key to exoplanet evolution”, Ages^2 – Taking Stellar Ages to the next Power, Elba, Italy	2017/09
	“Stellar activity and planet characterization”, Ringberg conference Atmospheres of Disks and Planets’, Castle Ringberg, Germany	2017/04
	“Interactions between exoplanets and their host stars”, Exoplanets – Bridging the Gap between Theory and Observations, Bad Honnef, Germany	2016/11
	“Tidal effects on stellar activity”, IAU Symposium 328 ‘Living around Active Stars’, Maresias, Brazil	2016/10
	“X-rays revealing the physics of exoplanets”, The X-ray Surveyor Conference, Washington DC, USA	2015/10
	“Stars and exoplanets: interaction, rotation, activity”, Stellar and Planetary Dynamos Conference, Göttingen, Germany	2015/05
	“The Interactions of Exoplanets with their Parent Stars”, American Astronomical Society Meeting 225, plenary review talk, Seattle, USA	2015/01
	“Stellar magnetic activity: Star-Planet Interactions”, CoRoT Symposium 3/Kepler KASC-7 Meeting, Toulouse, France	2014/07
	“Exoplanets and their hosts: why exoplanet science needs X-ray observations”, The X-ray Universe, Dublin, Ireland	2014/06
	“Star-Planet Interactions: coronal and chromospheric observations”, Second CoRoT Symposium, Marseille, France	2011/06

CONFERENCES & TALKS (CONT.)	<i>Invited colloquia and seminars:</i>	
	Astrophysics seminar, University of Amsterdam, Netherlands	2018/11
	Astrophysics seminar, Liverpool John Moores University, UK	2018/03
	Astrophysics seminar, University of Southampton, UK	2018/01
	Astronomy seminar, University of Warwick, UK	2017/10
	Astronomy seminar, University of Leeds, UK	2017/10
	Astronomy colloquium, Hamburg Observatory, Germany	2016/12
	Exoplanet seminar, University of St. Andrews, UK	2016/03
	Astronomy seminar, Edinburgh Royal Observatory, UK	2016/03
	Colloquium, MIT, USA	2015/09
	Colloquium, University of Massachusetts Amherst, USA	2015/04
	Planet and Star Formation Seminar, MPIA Heidelberg, Germany	2015/04
	Colloquium, Columbia University, New York, USA	2015/02
	Colloquium, University of Illinois, USA	2014/10
	Astrophysics seminar, Aarhus University, Denmark	2014/06
	YCAA Seminar, Yale University, New Haven, USA	2013/11
	Lunch Seminar, Boston University, Boston, USA	2013/10
	Exoplanet Science Seminar, JPL Pasadena, USA	2013/04
	Lunch Seminar, IPAC, Pasadena, USA	2013/04
	Colloquium, Astrophysics Institute Potsdam, Potsdam, Germany	2013/01
	Faculty Seminar, ESAC, Madrid, Spain	2012/06

*Contributed talks (selected):*

European Week of Astronomy & Space Science, Liverpool, UK	2018/04
IAU XXIX General Assembly, Hawaii, USA	2015/08
Sagan/Michelson Fellow Symposium, Pasadena, USA	2015/05
Chandra 15 Years Symposium, Boston, USA	2014/11
Cool Stars 19 Conference, Flagstaff, USA	2014/06
High-Energy Seminar, Center for Astrophysics, Cambridge, USA	2014/03
223rd AAS Meeting, National Harbor, USA	2014/01
45th DPS Meeting, Denver, USA	2013/10
IAU Symposium 302, Biarritz, France	2013/08
Visitor Colloquium, MPIA, Heidelberg, Germany	2013/01
Astronomy Colloquium, Hamburg Observatory	2013/01
IAU Symposium 286, Mendoza, Argentina	2011/10
7th Potsdam Thinkshop on magnetic fields in stars and exoplanets, Potsdam, Germany	2011/08
Cool Stars 16, splinter session on Frontiers in X-ray astronomy, Seattle, USA	2010/08

REFERENCES

1. Dr. Scott J. Wolk  
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5. Dr. Randall Smith  
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***Refereed publications, supervised students underlined:***

Wells, R.; **Poppenhaeger, K.**; Watson, C. A.: “Three small transiting planets around the M dwarf host star LP 358-499”, Monthly Notices of the Royal Astronomical Society Letters, 473, 1, p.L131-L134, 2018.

<http://adsabs.harvard.edu/abs/2018MNRAS.473L.131W>

Keenan, F. P.; **Poppenhaeger, K.**; Mathioudakis, M.; Rose, S. J.; Flowerdew, J.; Hynes, D.; Christian, D. J.; Nilsen, J.; Johnson, W. R., “X-ray line coincidence photopumping in a solar flare”, Monthly Notices of the Royal Astronomical Society, Volume 474, Issue 3, p.3782-3786, 2018.

<http://adsabs.harvard.edu/abs/2018MNRAS.474.3782K>

Wells, R.; **Poppenhaeger, K.**; Watson, C. A.; Heller, R., “Transit Visibility Zones of the Solar System Planets”, Monthly Notices of the Royal Astronomical Society, Volume 473, Issue 1, p.345-354, 2018.

<http://adsabs.harvard.edu/abs/2018MNRAS.473..345W>

- featured in press release of the Royal Astronomical Society 2017 ([www.ras.org.uk/news-and-press/3042-are-we-being-watched-tens-of-other-worlds-could-spot-the-earth](http://www.ras.org.uk/news-and-press/3042-are-we-being-watched-tens-of-other-worlds-could-spot-the-earth))

Günther, Maximilian N. and 38 co-authors including **Poppenhaeger, Katja**, “Unmasking the hidden NGTS-3Ab: a hot Jupiter in an unresolved binary system”, accepted for publication in Monthly Notices of the Royal Astronomical Society, 2018.

<http://adsabs.harvard.edu/abs/2018arXiv180501378G>

Bayliss, Daniel and 42 co-authors including **Poppenhaeger, Katja**, “NGTS-1b: a hot Jupiter transiting an M-dwarf”, Monthly Notices of the Royal Astronomical Society, Volume 475, Issue 4, p.4467-4475, 2018.

<http://adsabs.harvard.edu/abs/2018MNRAS.475.4467B>

- featured in press release by Queen’s University Belfast and the University of Warwick 2017 (<http://www.qub.ac.uk/News/Allnews/Monsterplanetdiscoverychallengesformationtheory.html>)

Wheatley, Peter J. and 45 co-authors including **Poppenhaeger, Katja**, “The Next Generation Transit Survey (NGTS)”, Monthly Notices of the Royal Astronomical Society, Volume 475, Issue 4, p.4476-4493, 2018.

<http://adsabs.harvard.edu/abs/2018MNRAS.475.4476W>

Wolk, Scott J.; Günther, H. Moritz; **Poppenhaeger, Katja**; Winston, E.; Rebull, L. M.; Stauffer, J. R.; Gutermuth, R. A.; Cody, A. M.; Hillenbrand, L. A.; Plavchan, P.; Covey, K. R.; Song, Inseok, “YSOVAR: Mid-infrared Variability among YSOs in the Star Formation Region Serpens South”, The Astronomical Journal, Volume 155, Issue 2, article id. 99, 20 pp., 2018.

<http://adsabs.harvard.edu/abs/2018AJ....155...99W>

von Essen, C. and 36 co-authors including **Poppenhaeger, K.**, “Kepler Object of Interest Network I. First results combining ground and space-based observations of Kepler systems with transit timing variations”, submitted to Astronomy & As-

trophysics, 2018.

<http://adsabs.harvard.edu/abs/2018arXiv180106191V>

Booth, R. S.; **Poppenhaeger, K.**; Watson, C. A.; Silva Aguirre, V.; Wolk, S. J., “An Improved Age-Activity Relationship for Cool Stars older than a Gigayear”, Monthly Notices of the Royal Astronomical Society, Volume 471, Issue 1, p.1012-1025, 2017.

<http://adsabs.harvard.edu/abs/2017MNRAS.471.1012B>

- featured in press release by NASA 2017 ([www.nasa.gov/mission\\_pages/chandra/news/x-rays-reveal-temperament-of-possible-planet-hosting-stars.html](http://www.nasa.gov/mission_pages/chandra/news/x-rays-reveal-temperament-of-possible-planet-hosting-stars.html))

**Poppenhaeger, K.**; Auchettl, K.; Wolk, S. J., “A test of the neutron star hypothesis for Fomalhaut b”, Monthly Notices of the Royal Astronomical Society 468 4 4018, 2017.

<http://adsabs.harvard.edu/abs/2017MNRAS.468.4018P>

Günther, M. N. and 25 co-authors including **Poppenhaeger, K.**, “Centroid vetting of transiting planet candidates from the Next Generation Transit Survey”, Monthly Notices of the Royal Astronomical Society, Volume 472, Issue 1, p.295-307, 2017.

<http://adsabs.harvard.edu/abs/2017MNRAS.472..295G>

Yadav, R. K.; Christensen, U. R.; Wolk, S. J.; **Poppenhaeger, K.**, “Magnetic cycles in a dynamo simulation of the fully convective M-star Proxima Centauri”, The Astrophysical Journal Letters, Volume 833 2 L28, 2016.

<http://adsabs.harvard.edu/abs/2016ApJ...833L..28Y>

Günther, H. M.; Kraus, S.; Melis, C.; Cur, M.; Harries, T.; Ireland, M.; Kanaan, S.; **Poppenhaeger, K.**; Rizzuto, A.; Rodriguez, D.; Schneider, C. P.; Sitko, M.; Weigelt, G.; Willson, M.; Wolk, S., “TYC 8241 2652 1 and the case of the disappearing disk: no smoking gun yet”, Astronomy & Astrophysics, Volume 598, id.A82, 2016.

<http://adsabs.harvard.edu/abs/2017A%26A...598A..82G>

Yadav, R. K.; Gastine, T.; Christensen, U. R.; Wolk, S. J.; **Poppenhaeger, K.**, “Approaching a realistic force balance in geodynamo simulations”, Proceedings of the National Academy of Sciences, vol. 113, issue 43, pp.12065-12070, 2016.

<http://adsabs.harvard.edu/abs/2016PNAS..11312065Y>

Brenneman, Laura W. and 33 co-authors including **Poppenhaeger, K.**, “The evolution of structure and feedback with Arcus”, Proceedings of the SPIE, Volume 9905, id. 99054P 18 pp., 2016.

<http://adsabs.harvard.edu/abs/2016SPIE.9905E..4PB>

Smith, R. K. and 46 co-authors including **Poppenhaeger, K.**, “Arcus: the x-ray grating spectrometer explorer”, Proceedings of the SPIE, Volume 9905, id. 99054M 7 pp., 2016.

<http://adsabs.harvard.edu/abs/2016SPIE.9905E..4MS>

**Poppenhaeger, K.**; Cody, A.M.; Covey, K.R.; Espaillat, C.; Forbrich, J.;

Günther, H.M.; Gutermuth, R.A.; Hillenbrand, L.A.; Hora, J.L.; Morales-Calderón, M.; Plavchan, P.; Rebull, L.M.; Song, I.; Stauffer, J.R.; Wolk, S.J., “YSOVAR: Mid-infrared variability of young stellar objects and their disks in the cluster IRAS 20050+2720”, *The Astronomical Journal* 150 4 id. 118, 2015.

<http://adsabs.harvard.edu/abs/2015AJ....150..118P>

Yadav, R.K.; Christensen, U.R.; Morin, J.; Gastine, T.; Reiners, A.; **Poppenhaeger, K.**; Wolk, S.J., “Explaining the Coexistence of Large-scale and Small-scale Magnetic Fields in Fully Convective Stars”, *The Astrophysical Journal Letters* 813 2 id.L31 2015.

<http://adsabs.harvard.edu/abs/2015ApJ...813L..31Y>

Rebull, L. M.; Stauffer, J. R.; Cody, A. M.; Guenther, H. M.; Hillenbrand, L. A.; **Poppenhaeger, K.**; Wolk, S. J.; Hora, J.; Hernandez, J.; Bayo, A.; Covey, K.; Forbrich, J.; Gutermuth, R.; Morales-Calderon, M.; Plavchan, P.; Song, I.; Bouy, H.; Terebey, S.; Cuillandre, J. C.; Allen, L., “YSOVAR: Mid-Infrared Variability in NGC 1333”, *The Astronomical Journal* 150 5 id.145, 2015.

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**Poppenhaeger, K.** and Wolk, S. J. “Indications for an influence of Hot Jupiters on the rotation and activity of their host stars”, *Astronomy & Astrophysics Letters* 565 id.L1, 2014.

<http://adsabs.harvard.edu/abs/2014A%26A...565L...1P>

- featured in Nature Research Highlights May 2014, “Big planets could alter star rotation”,

<http://www.nature.com/nature/journal/v509/n7500/full/509263c.html>

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- featured in Science Update of the Harvard-Smithsonian Center for Astrophysics, December 2014, “Twinkle, Twinkle, New-Born Star”,

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Lalitha, S.; **Poppenhaeger, K.**; Singh, K.P.; Czesla, S.; Schmitt, J.H.M.M., “X-ray emission from the super-earth host GJ 1214”, *The Astrophysical Journal Letters* 790 1 L11, 2014.

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Cohen, O.; Drake, J. J.; Glocer, A.; Garraffo, C.; **Poppenhaeger, K.**; Bell, J. M.; Ridley, A. J.; Gombosi, T. I., “Magnetospheric structure and atmospheric Joule heating of habitable planets orbiting M-dwarf stars”, *The Astrophysical Journal* 790 1 id.57, 2014.

<http://adsabs.harvard.edu/abs/2014ApJ...790...57C>

- featured in press release at the 224th meeting of the American Astronomical Society, June 2014, “Harsh space weather may doom potential life on red-dwarf planets”,

<http://www.cfa.harvard.edu/news/2014-11>

Cody, A. M. and 44 co-authors including **Poppenhaeger, K.**, “CSI 2264: Simultaneous optical and infrared light curves of young disk-bearing stars in NGC 2264 with CoRoT and Spitzer—evidence for multiple origins of variability”, *The Astronomical Journal* 147 4 id.82, 2014.

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**Poppenhaeger, K.**, Schmitt, J. H. M. M., and Wolk, S. J. “Transit Observations of the Hot Jupiter HD 189733b at X-Ray Wavelengths”, *The Astrophysical Journal* 773 1 id.62, 2013.

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- featured in NASA press release July 2013, “NASA’s Chandra Sees Eclipsing Planet in X-rays for First Time”,

[http://www.nasa.gov/mission\\_pages/chandra/news/exoplanet-HD189733b.html](http://www.nasa.gov/mission_pages/chandra/news/exoplanet-HD189733b.html)

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**Poppenhaeger, K.**, Günther, H.M., and Schmitt, J.H.M.M., “A magnetic cycle of  $\tau$  Bootis? The coronal and chromospheric view”, *Astronomical Notes* 333 1 26, 2012.

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