

# Stellar flares and habitable(?) M-dwarf worlds explored with TESS

Maximilian N. Günther  
(Torres Fellow, MIT)



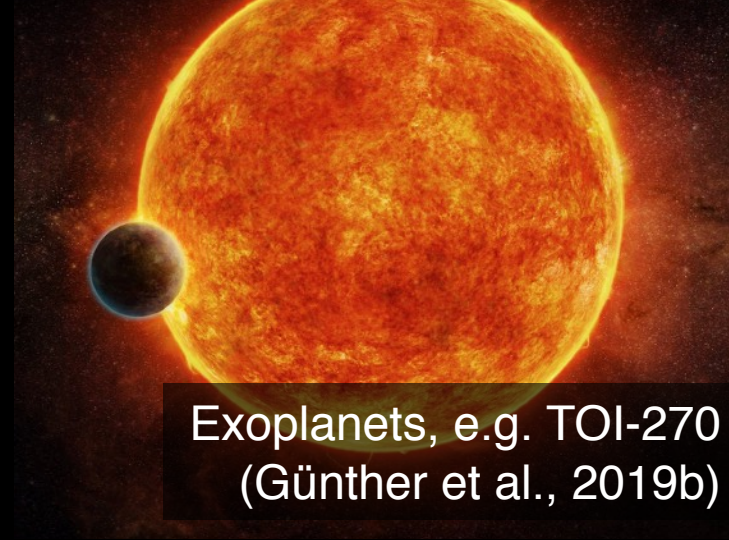
@M\_N\_Guenther

TESS Sci Con I, July/Aug 2019

maxgue@mit.edu



Stellar flares  
(Günther et al., 2019a)



Exoplanets, e.g. TOI-270  
(Günther et al., 2019b)



Young stars, rotation, spots  
(Zhan, Günther et al., 2019)



Non-habitable M-dwarf worlds...

... and why flares are important

# A super-Earth and two sub-Neptunes transiting the nearby and quiet M dwarf TOI-270

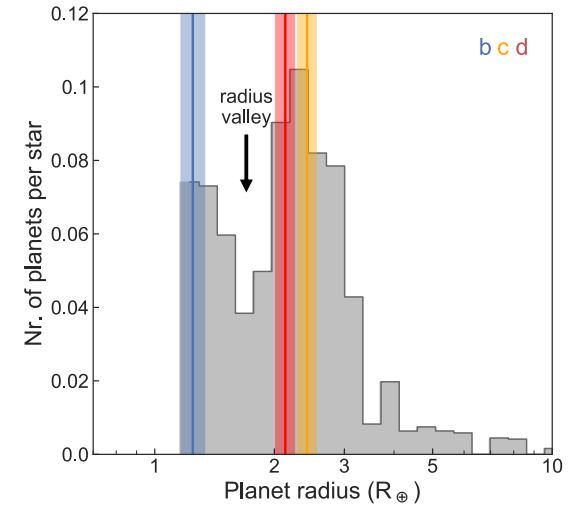
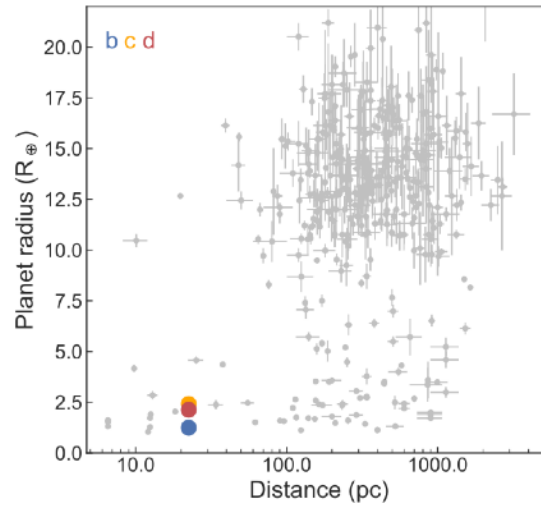
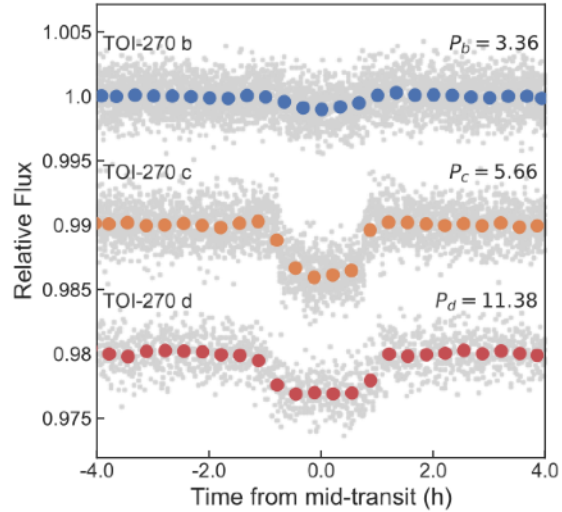
Maximilian N. Günther<sup>1\*</sup>, Francisco J. Pozuelos<sup>2,3</sup>, Jason A. Dittmann<sup>4</sup>, Diana Dragomir<sup>1</sup>, Stephen R. Kane<sup>5</sup>, Tansu Daylan<sup>1</sup>, Adina D. Feinstein<sup>6</sup>, Chelsea X. Huang<sup>1</sup>, Timothy D. Morton<sup>7</sup>, Andrea Bonfanti<sup>2</sup>, L. G. Bouma<sup>8</sup>, Jennifer Burt<sup>1</sup>, Karen A. Collins<sup>9</sup>, Jack J. Lissauer<sup>10</sup>, Elisabeth Matthews<sup>1</sup>, Benjamin T. Montet<sup>6</sup>, Andrew Vanderburg<sup>11</sup>, Songhu Wang<sup>12</sup>, Jennifer G. Winters<sup>9</sup>, George R. Ricker<sup>1</sup>, Roland K. Vanderpek<sup>1</sup>, David W. Latham<sup>9</sup>, Sara Seager<sup>1,4,13</sup>, Joshua N. Winn<sup>8</sup>, Jon M. Jenkins<sup>10</sup>, James D. Armstrong<sup>14</sup>, Khalid Barkaoui<sup>3,15</sup>, Natalie Batalha<sup>16</sup>, Jacob L. Bean<sup>6</sup>, Douglas A. Caldwell<sup>17</sup>, David R. Ciardi<sup>17</sup>, Kevin I. Collins<sup>18</sup>, Ian Crossfield<sup>1</sup>, Michael Fausnaugh<sup>1</sup>, Gabor Furesz<sup>1</sup>, Tianjun Gan<sup>19</sup>, Michaël Gillon<sup>3</sup>, Natalia Guerrero<sup>1</sup>, Keith Horne<sup>20</sup>, Steve B. Howell<sup>10</sup>, Michael Ireland<sup>21</sup>, Giovanni Isopi<sup>22</sup>, Emmanuël Jehin<sup>2</sup>, John F. Kielkopf<sup>23</sup>, Sebastien Lepine<sup>24</sup>, Franco Mallia<sup>22</sup>, Rachel A. Matson<sup>10</sup>, Gordon Myers<sup>25</sup>, Enric Palle<sup>26,27</sup>, Samuel N. Quinn<sup>9</sup>, Howard M. Relles<sup>1</sup>, Bárbara Rojas-Ayala<sup>28</sup>, Joshua Schlieder<sup>29</sup>, Ramotholo Sefako<sup>30</sup>, Avi Shporer<sup>1</sup>, Juan C. Suárez<sup>31,32</sup>, Thiam-Guan Tan<sup>33</sup>, Eric B. Ting<sup>10</sup>, Joseph D. Twicken<sup>34</sup> and Ian A. Waite<sup>35</sup>

## A super-Earth and two sub-Neptunes transiting the nearby and quiet M dwarf TOI-270

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Mauro Focardi, Malcolm Fridlund, Thomas Friedli, Akihiko Fukui, BJ Fulton, Eric Gaidos, Davide Gandolfi, Scott Gaudi, Jian Ge, Steven Giacalone, Aidan Gibbs, Michael Gillon, Eric Girardin, Ana Glidden, Vayujeet Gokhale, Erica Gonzales, Joao Gregorio, Sam Grunblatt, Frank Grupp, Sascha Grziwa, Eike Guenther, Pere Guerra, Natalia Guerrero, Tristan Guillot, Maximilian Günther, Sam Hadden, Daniel Harbeck, Kevin Hardegree-Ullman, Rhodes Hart, Joel Hartman, Artie Hatzes, Coel Hellier, Krzysztof Hellmich, Arne Henden, Thomas Henning, Enrique Herrero, Brian Hill, Michelle Hill, Eric Hintz, Lea Hirsch, Ariana Hofelmann, Elliott Horch, Jonti Horner, Andrew Howard, Steve Howell, Chelsea Huang, Jerry Hubbell, Dan Huber, Guillaume Hébrard, Jonathan Irwin, Howard Isaacson, Hannah Jang-Condell, James Jenkins, Eric Jensen, Marshall Johnson, Mike Jone, Hugh Jones, Andres Jordan, Stella Kafka, Adrian Kaminski, Stephen Kane, Hanna Kellermann, Jonas Kemmer, Eliza Kempton, John Kielkopf, Chip Kobulnicky, Molly Kosiarek, Diana Kossakowski, Cliff Kotnik, Laura Kreidberg, Vadim Krushinsky, Jonathan Labadie-Bartz, François-René Lachapelle, David Lafreniere, Didier Laloum, Dave Latham, Nicholas Law, Pablo Lewin, Tiffany Lewis, Jorge Lillo-Box, Yulong Liu, John Livingston, James Lowenthal, Mike Lund, Rafael Luque, Franco Mallia, Christopher Mann, Bob Massey, Rachel Matson, Elisabeth Matthews, Andrew Mayo, Mori Mayuko, Tsevi Mazeh, Kim McLeod, Djamel Mekarnia, Ken Menzies, Michael Meyer, Anatoly Miroshnichenko, Nikolay Mishevsky, Pilar Montanes-Rodriguez, Ben Montet, Maria Morales-Calderón, Teo Mosnik, Georgia Mraz, Gabriel Murawski, Felipe Murgas, Gordon Myers, Luca Naponiello, Norio Narita, Peter Nelson, Elisabeth Newton, Henry Ngo, Louise Nielsen, Grzegorz Nowak, Thomas Oberst, Emanuele Pace, Enric Palle, Harvey Patashnick, Rafal Pawlaszek, Joshua Pepper, Carina Persson, Georg Piehler, Michael Pierce, Caty Pilachowski, Jean-Bernard Pioppa, Peter Plavchan, Tomasz Popajewski, Francisco J. Pozuelos-Romero, Sam Quinn, Markus Rabus, Benjamin Rackham, Don Radford, Phill Reed, Francois Regembal, Howard Relles, Helena Richie, Arno Riffeser, Joey Rodriguez, Jason Rowe, Arpita Roy, Ryan Rubenzahl, Alexandre Santerne, Bun'ei Sato, Martin Schlecker, Josh Schlieder, Rick Schwarz, Sara Seager, Hakan Senavci, Sahar Shahaf, Avi Shporer, Rob Siverd, David Sliski, Abderahmane Soubkiou, Alessandro Sozzetti, Gregor Srdoc, Ruggero Stanga, Keivan Stassun, Amy Steele, Jason Steffen, Denise Stephens, Chris Stockdale, Geoff Stone, Jon Swift, Justin Tackett, TG Tan, Angelle Tanner, Michael Taube, Johanna Teske, Chris Tinney, Benjamin Tofflemire, Andrei Tokovinin, JanKare TrandemQvam, Trifon Trifonov, René TronsgaardRasmussen, Rob Trudel, Oliver Turner, Stéphane Udry, Gerard vanBelle, Vincent VanEylen, Siegfried Vanaverbeke, Andrew Vanderburg, Roland Vanderspek, Gautam Vasisht, Steven Villanueva, William Waalkes, Ian Waite, Bradley Walter, Ji Wang, Liang Wang, Sharon Wang, Songhu Wang, Lifan Wang, Lauren Weiss, William Welsh, Michael Werner, Ronald Wilhelm, Francis Wilkin, Geof Wingham, Josh Winn, Jen Winters, Rob Wittenmyer, Justin Wittrock, Ian Wong, Duncan Wright, Daniel Yahalomi, Xinyu Yao, Mesut Yilmaz, Roberto Zambelli, Hui Zhao, Fei Zhao, Gang Zhao, George Zhou, Carl Ziegler, + all engineers + all citizen scientists et al.



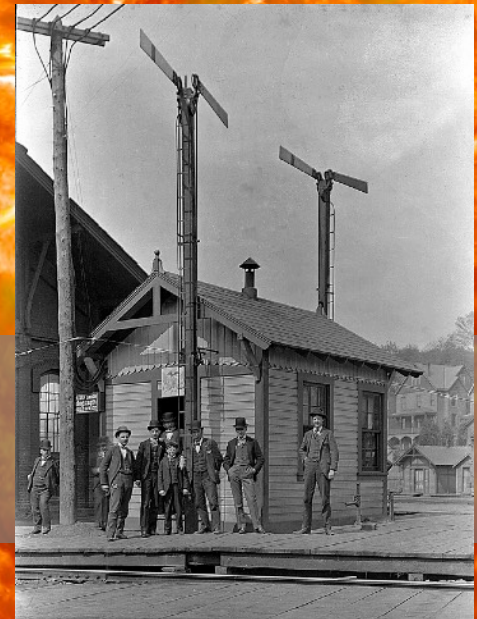
A laboratory for photo-evaporation.  
 Quiet now, but... what happened in the past?



## Stellar Flares and TESS

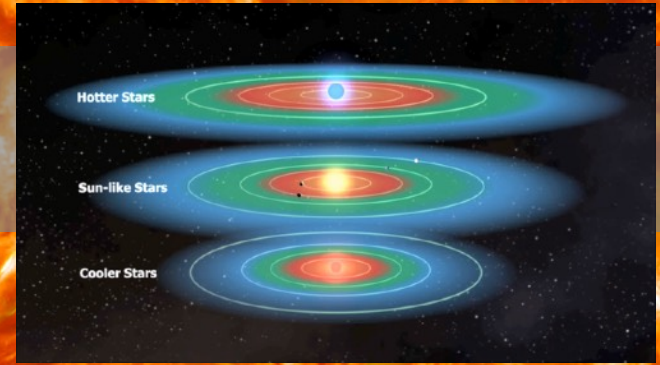
Explosive magnetic reconnection events  
*“The solar corona relaxes”*

Carrington Event, 1859  
Flare & coronal mass ejection ( $10^{32}$  erg)

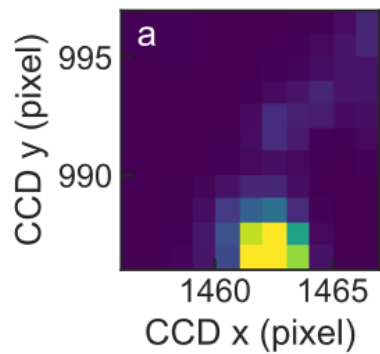


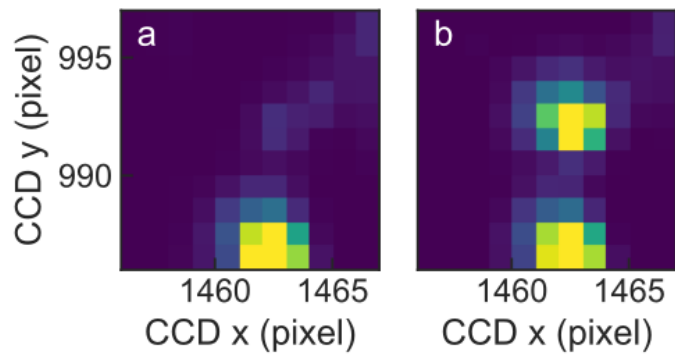


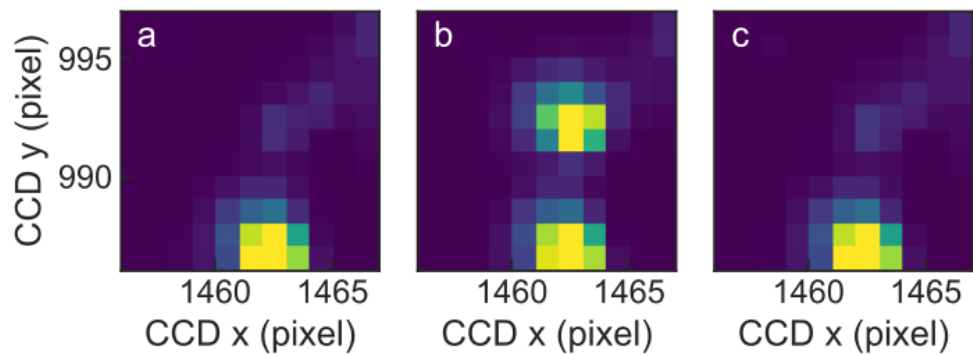
Danger for small exoplanets  
in the HZ of M-dwarfs ( $>10^{38}$  erg)

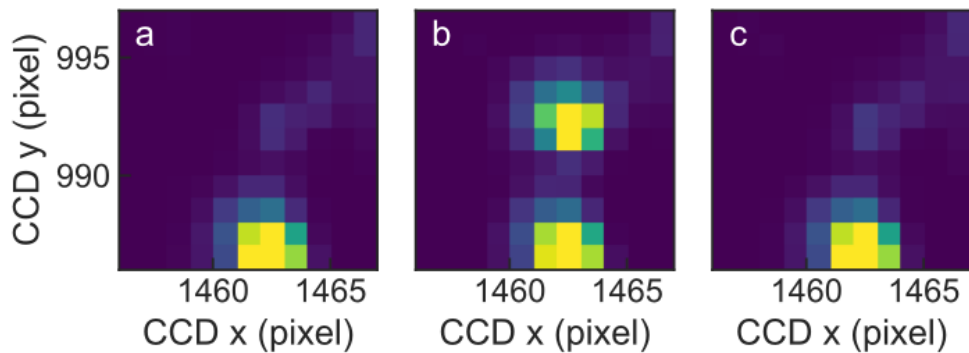
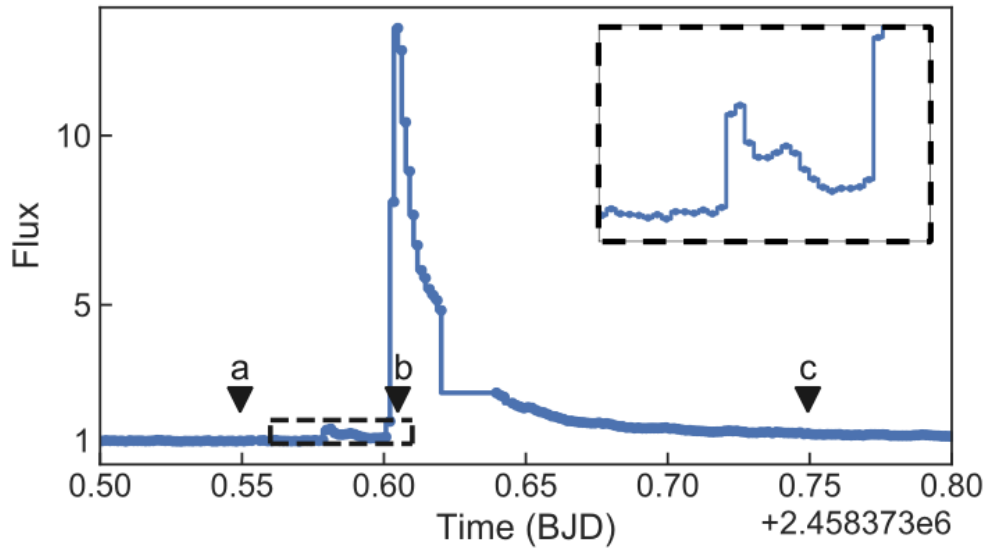


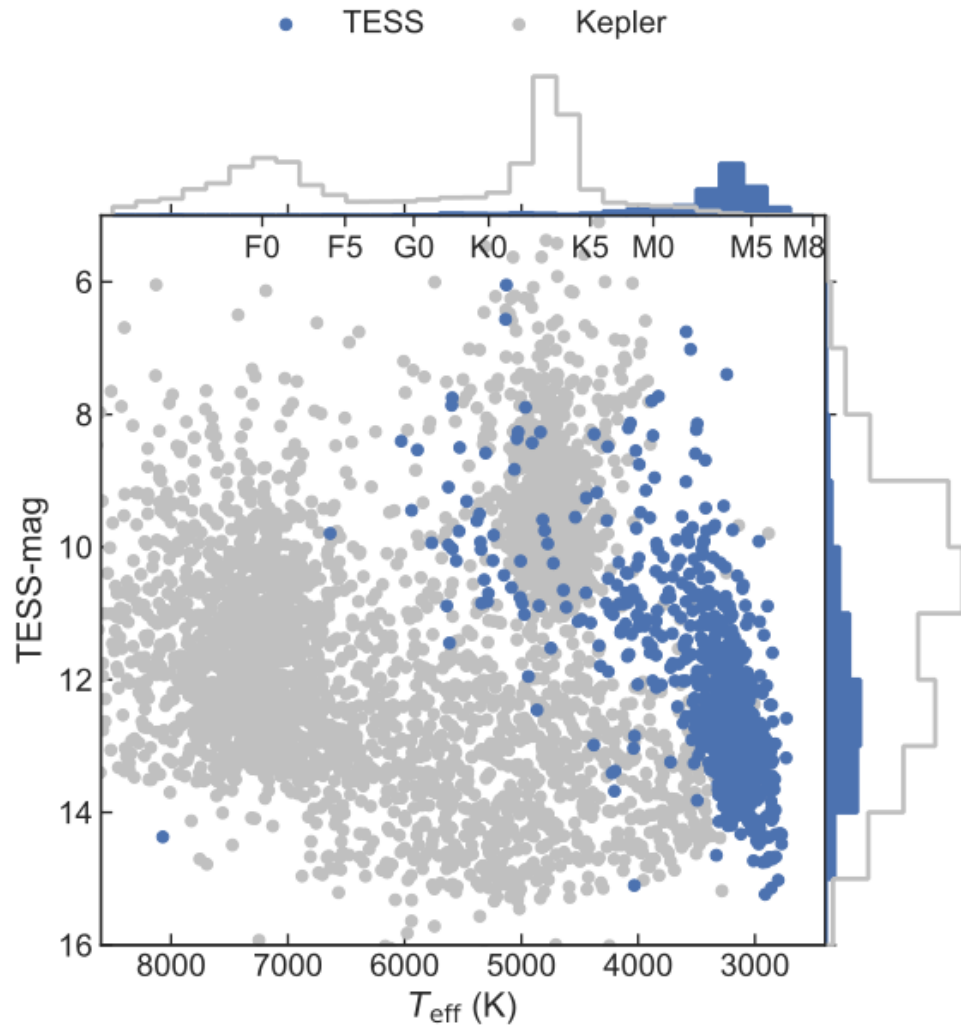
But can be **necessary** to deliver  
UV flux for prebiotic chemistry

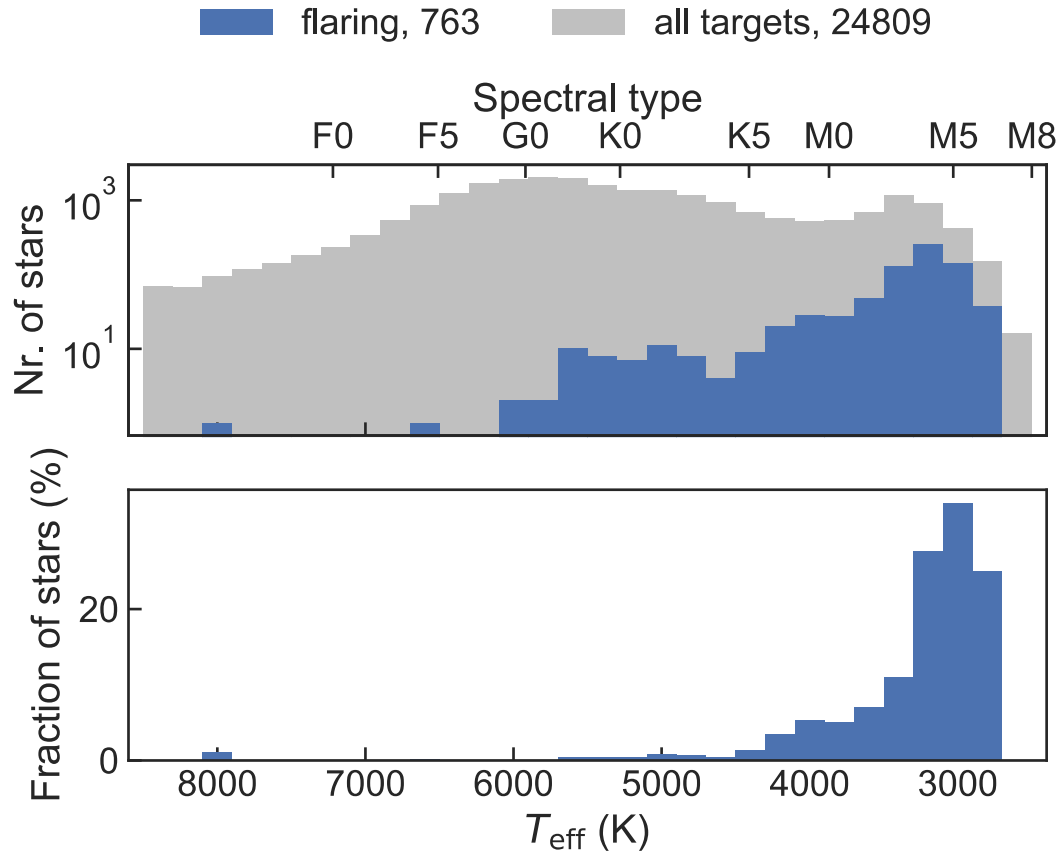


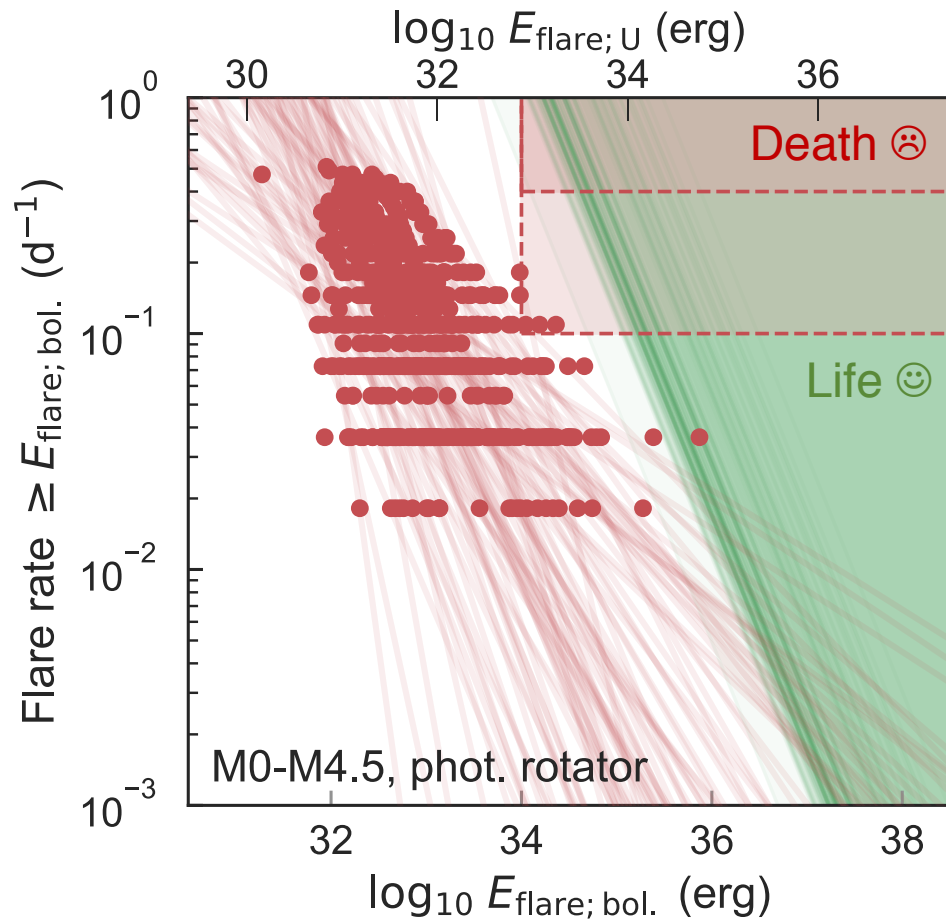








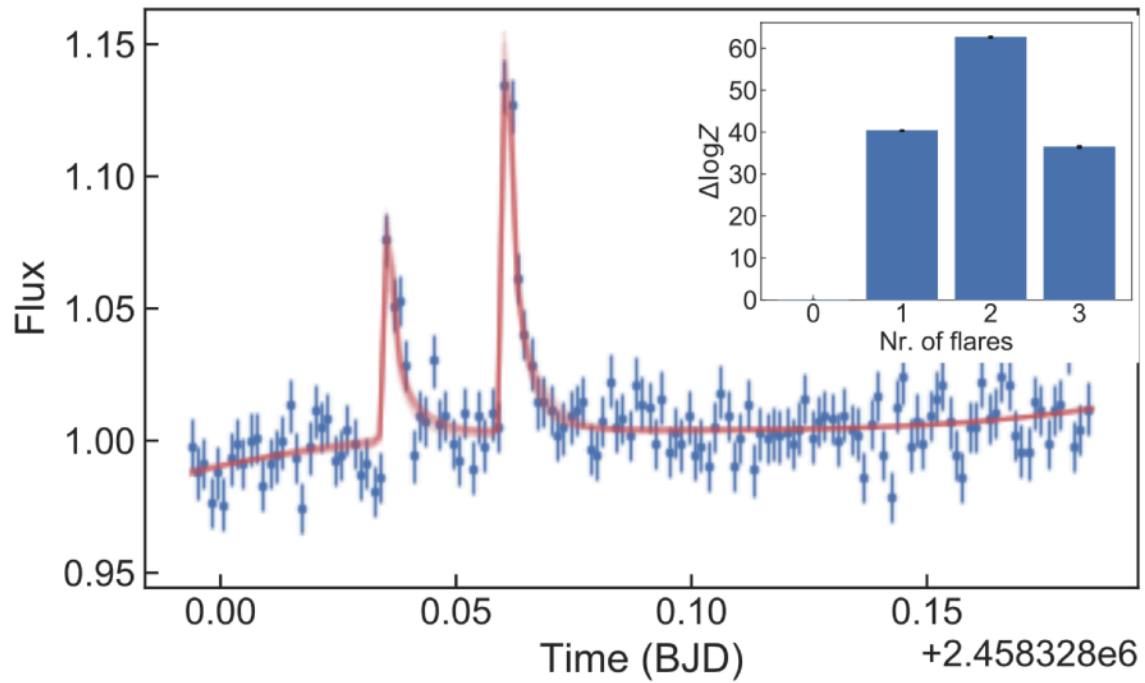


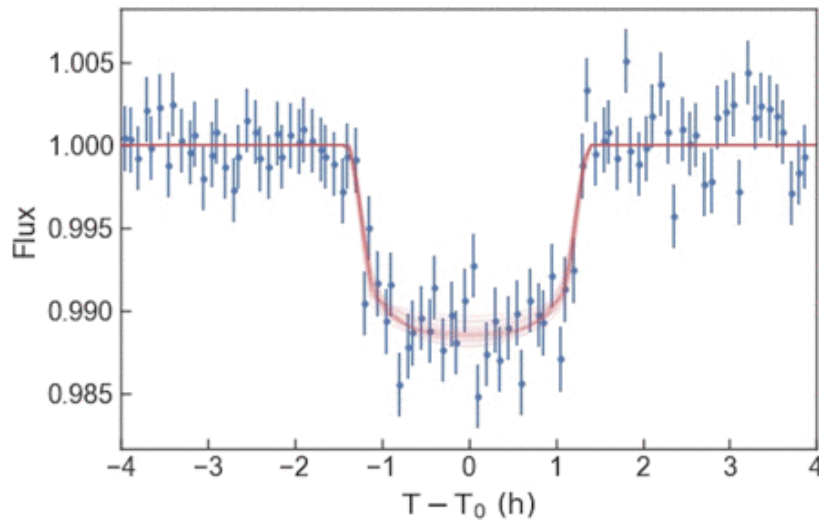


Tilley et al. 2019

Rimmer et al. 2018







Exoplanets | Binaries | Transits | RV Signals | Star Spots | Stellar Flares  
Gaussian Processes | MCMC | Nested Sampling



MNGuenter/allesfitter

Günther & Daylan (in prep.)



@M\_N\_Guenter

Maximilian N. Günther (MIT)

maxgue@mit.edu