The Future of the EAO JCMT-Transient Survey

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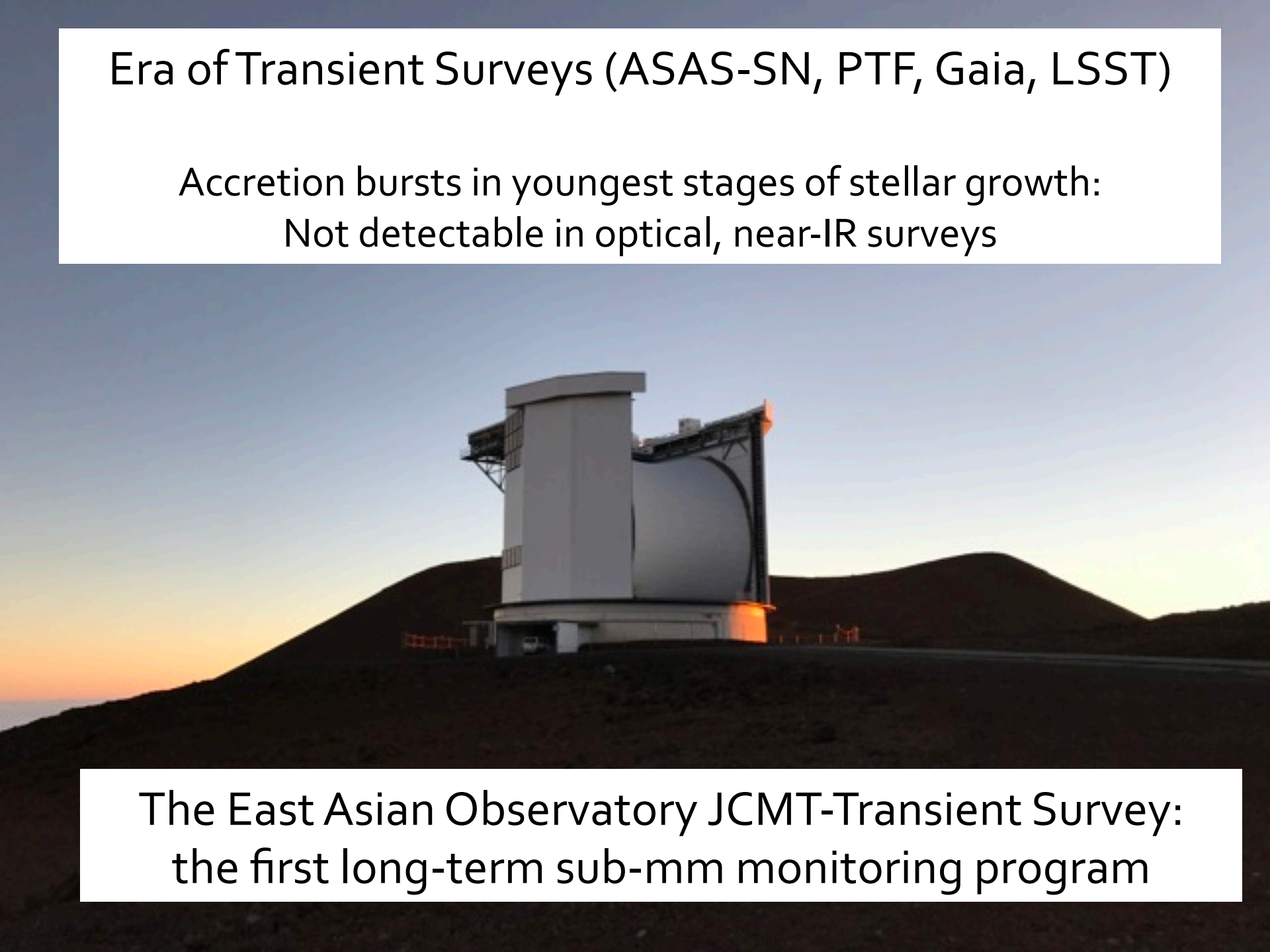
Era of Transient Surveys (ASAS-SN, PTF, Gaia, LSST)

Accretion bursts in youngest stages of stellar growth:
Not detectable in optical, near-IR surveys



The East Asian Observatory JCMT-Transient Survey:
the first long-term sub-mm monitoring program

Transient Team (~80 people total)

Yong-hee Lee, PhD student, Kyung-Hee Univ.

Coordinators

Gregory Herczeg (co-PI; PKU/China)
Doug Johnstone (co-PI; NRC/Canada)
Jeong-Eun Lee (KHU/Korea)
Yuri Aikawa (Tsukuba/Japan)
Geoff Bower (ASIAA/Taiwan)
Vivien Chen (NTU/Taiwan)
Jennifer Hatchell (Exeter/UK)

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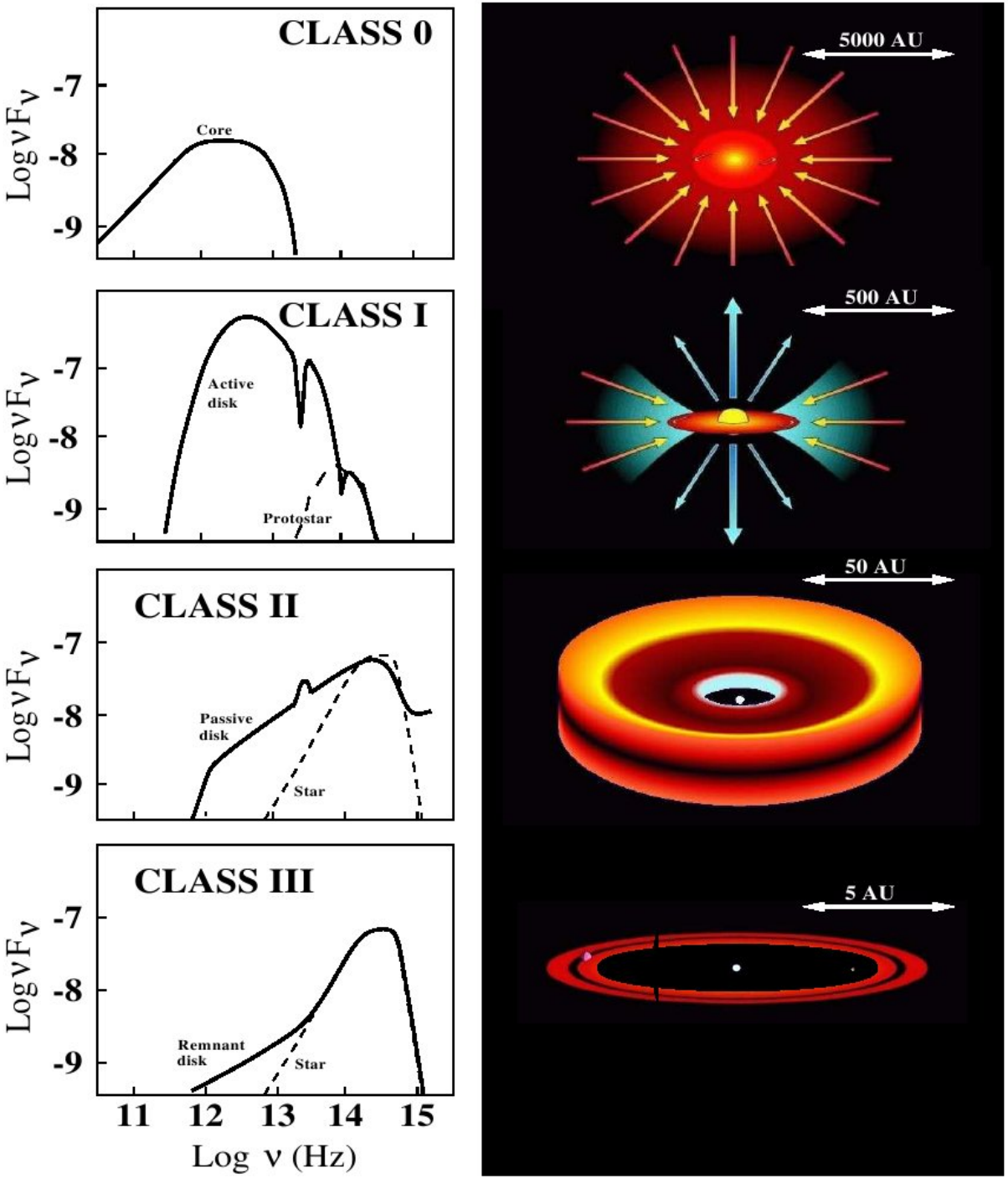
Modeling PhDs: Ben MacFarlane (UCL), Giseon Baek (Kyung-hee)

Related PhDs: Logan Francis, Sunkyung Park

Other significant contributors: Wen-Ping Chen, Sung-ju Kang, Seokho Lee, Graham Bell, Sarah Graves, Carlos Contreras-Pena, Tim Naylor, Miju Kang, Oscar Morata, Dimitris Stamatellos, Miju Kang, Aleks Scholz, Shu-Ichiro Inutsuka , Jan Forbrich, Helen Kirk

Friends of the program: Watson Varricatt (UKIRT), Klaus Hodapp (UH), Patrick Sheehan & John Tobin (NRAO)



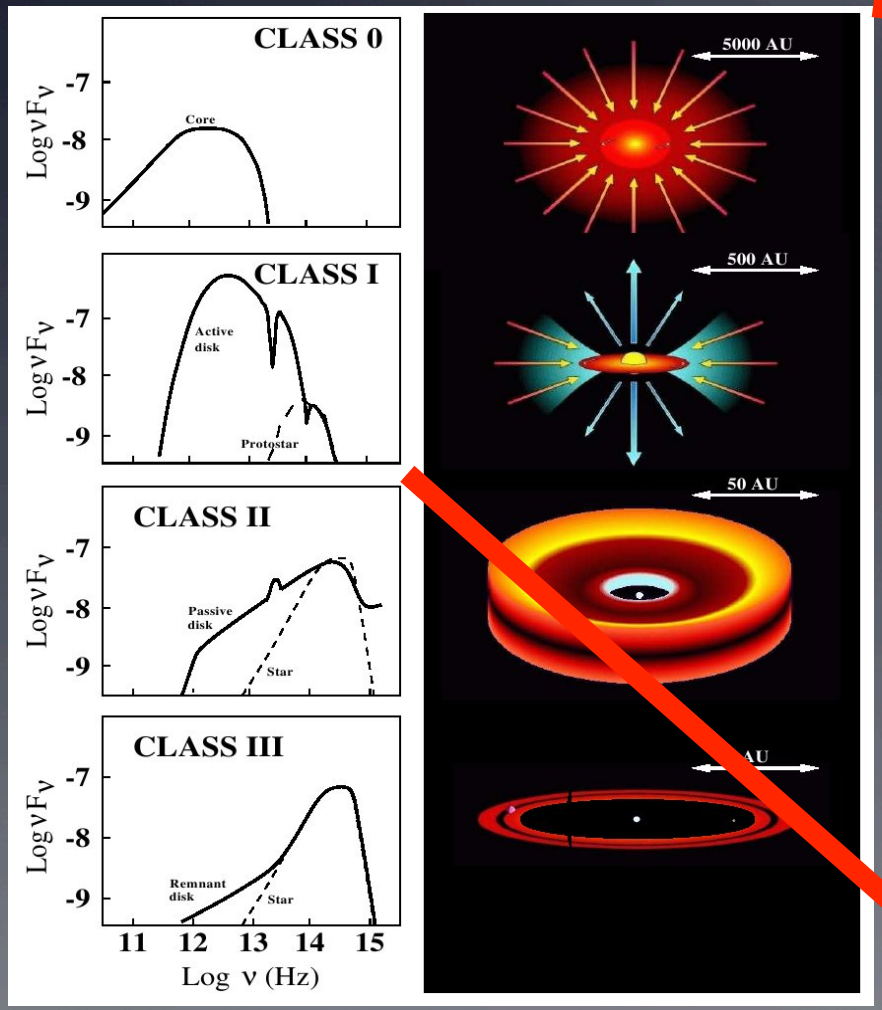
Protostellar Evolution

Cartoon from van Boekel 2005

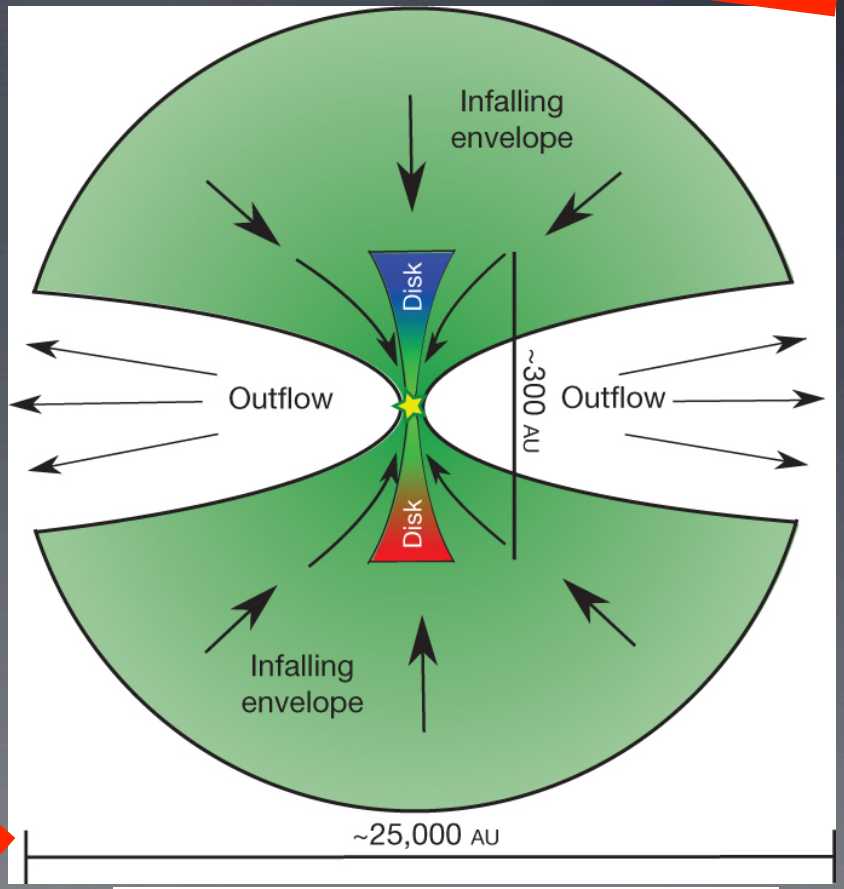
Stars grow during protostellar phase

$L_{tot}=L_{acc}+L_{phot}$

Scattered by dust

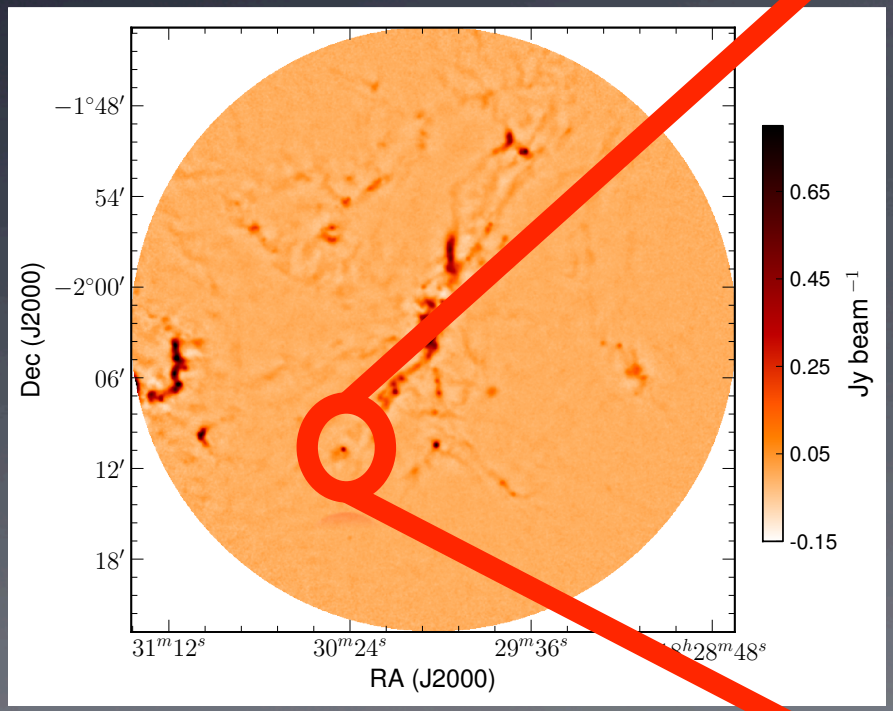


Cartoon from Isella 2006

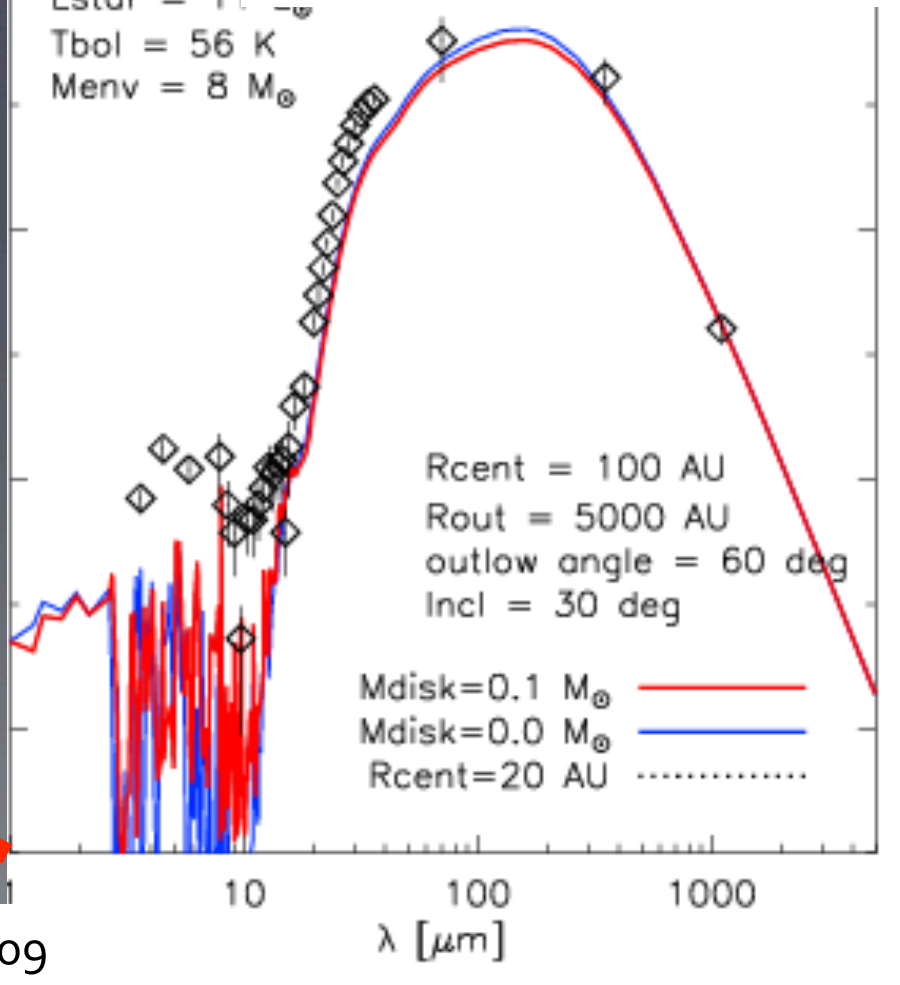


Cartoon from Tobin+2012

Spectral Energy Distribution



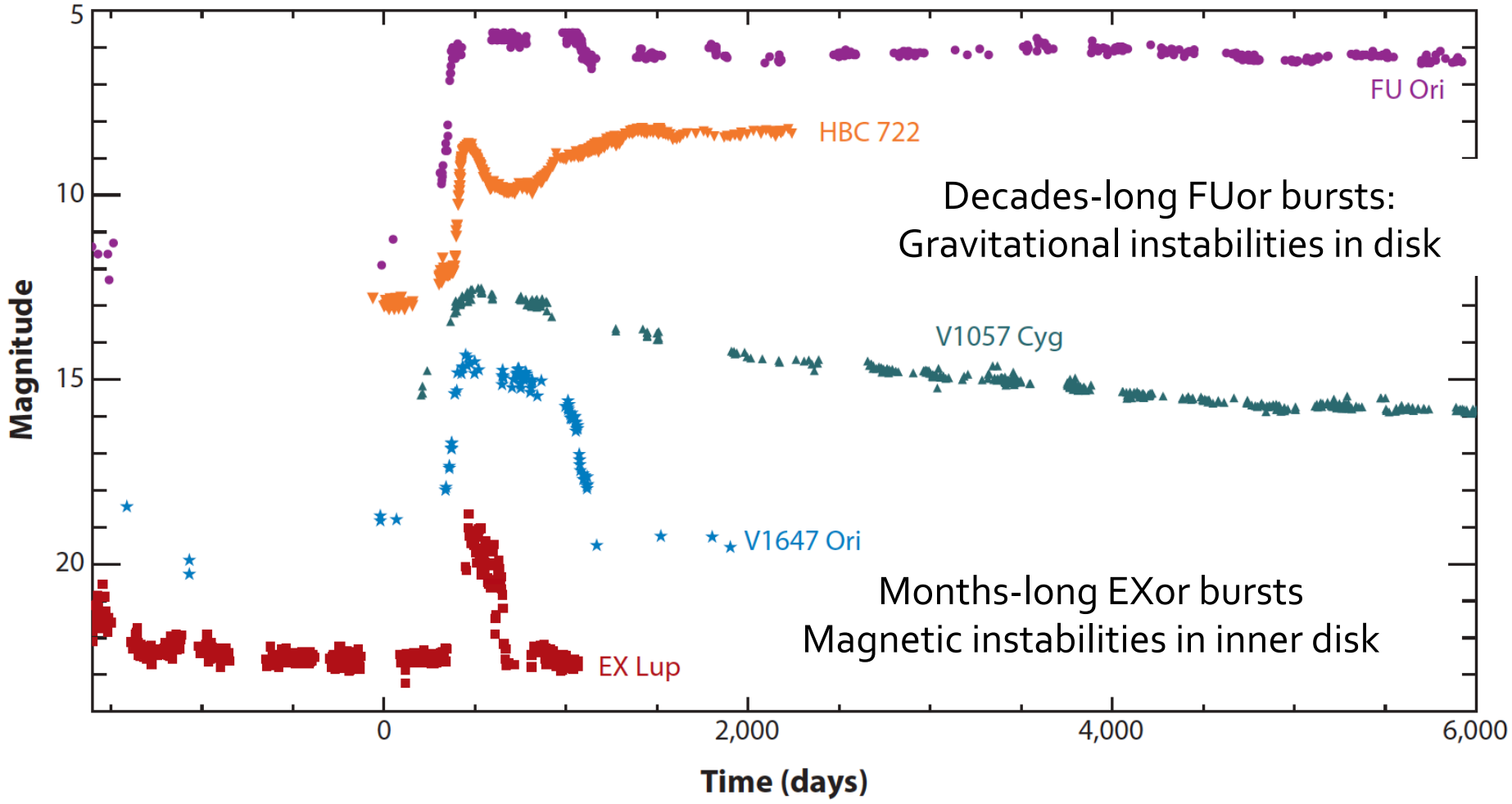
Measure Tbol (~peak of SED) and Lbol (luminosity)



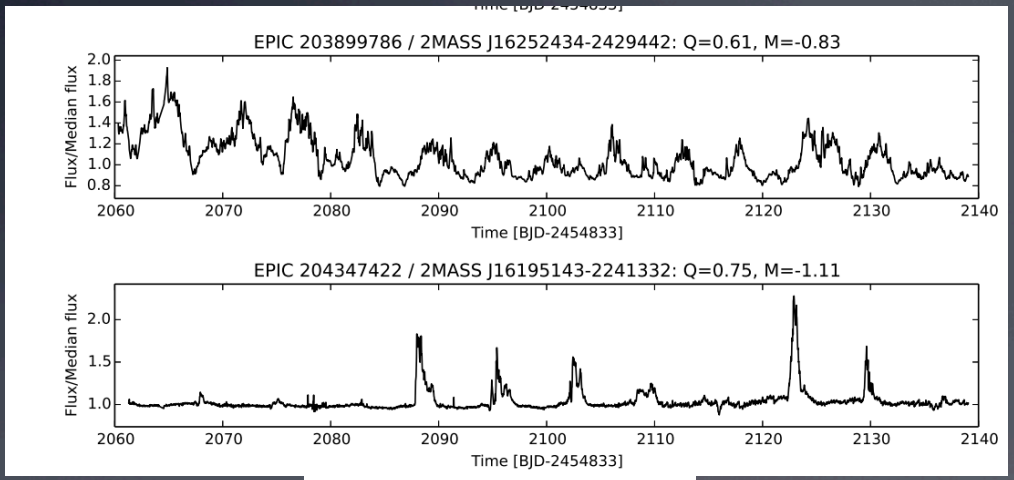
Enoch+2009

Disk instabilities and YSO variability

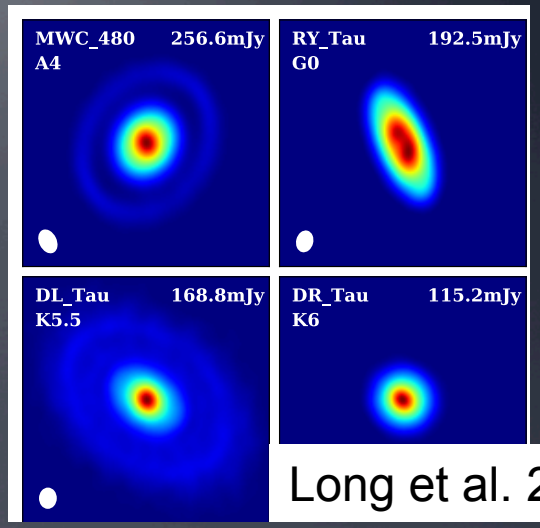
(adapted from Kospal+2011)



Disk instabilities and substructures

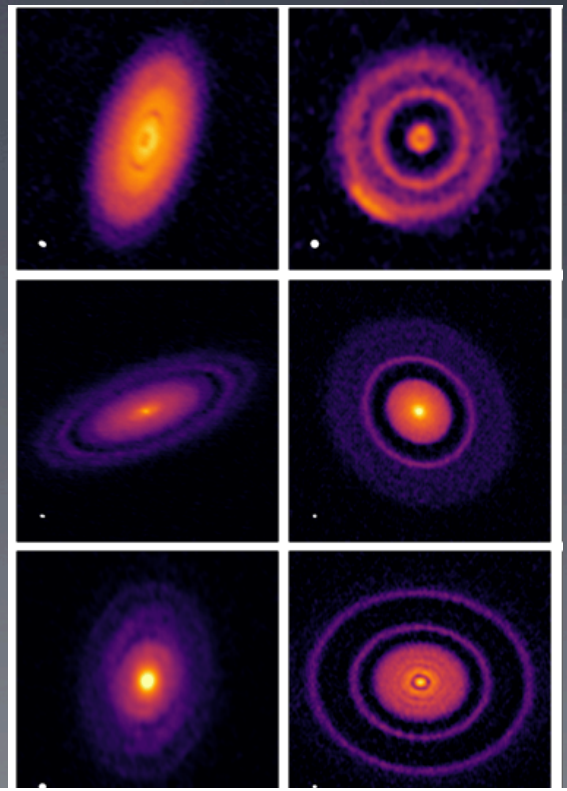


Cody et al. 2018



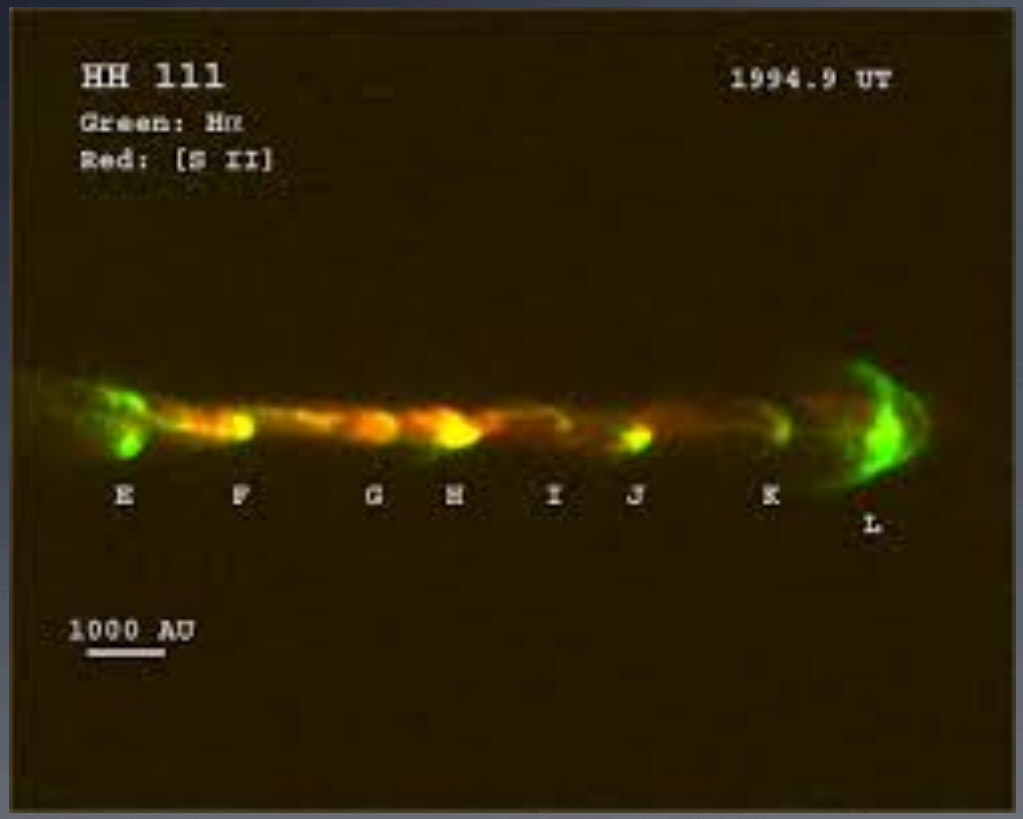
Long et al. 2018

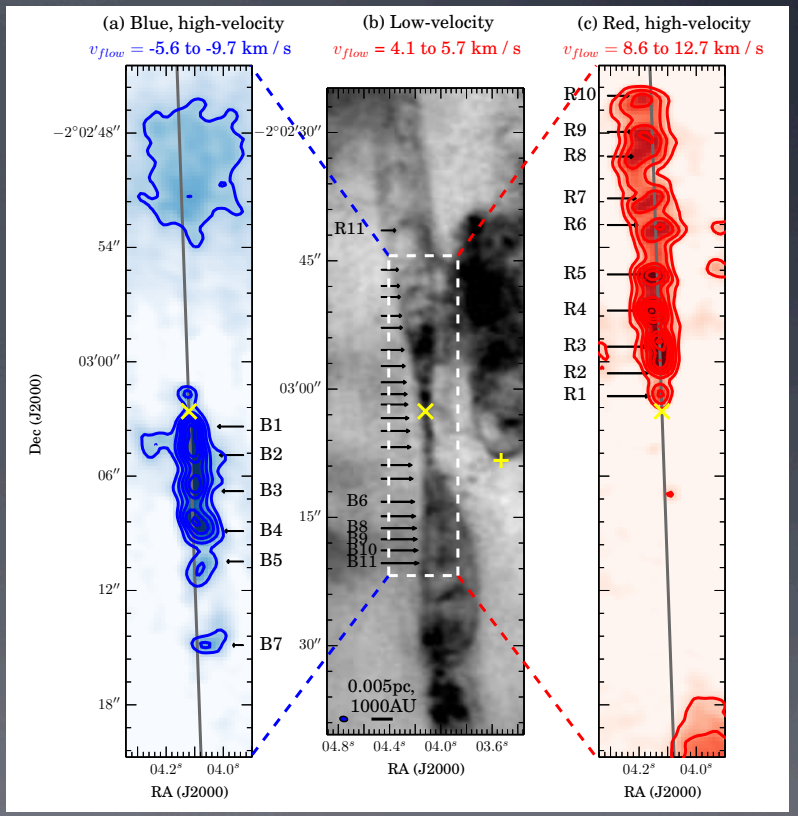
VLT-Sphere, Garufi et al. 2018



Andrews, Huang, et al. 2018

Periodic jet shocks and relationship to accretion?

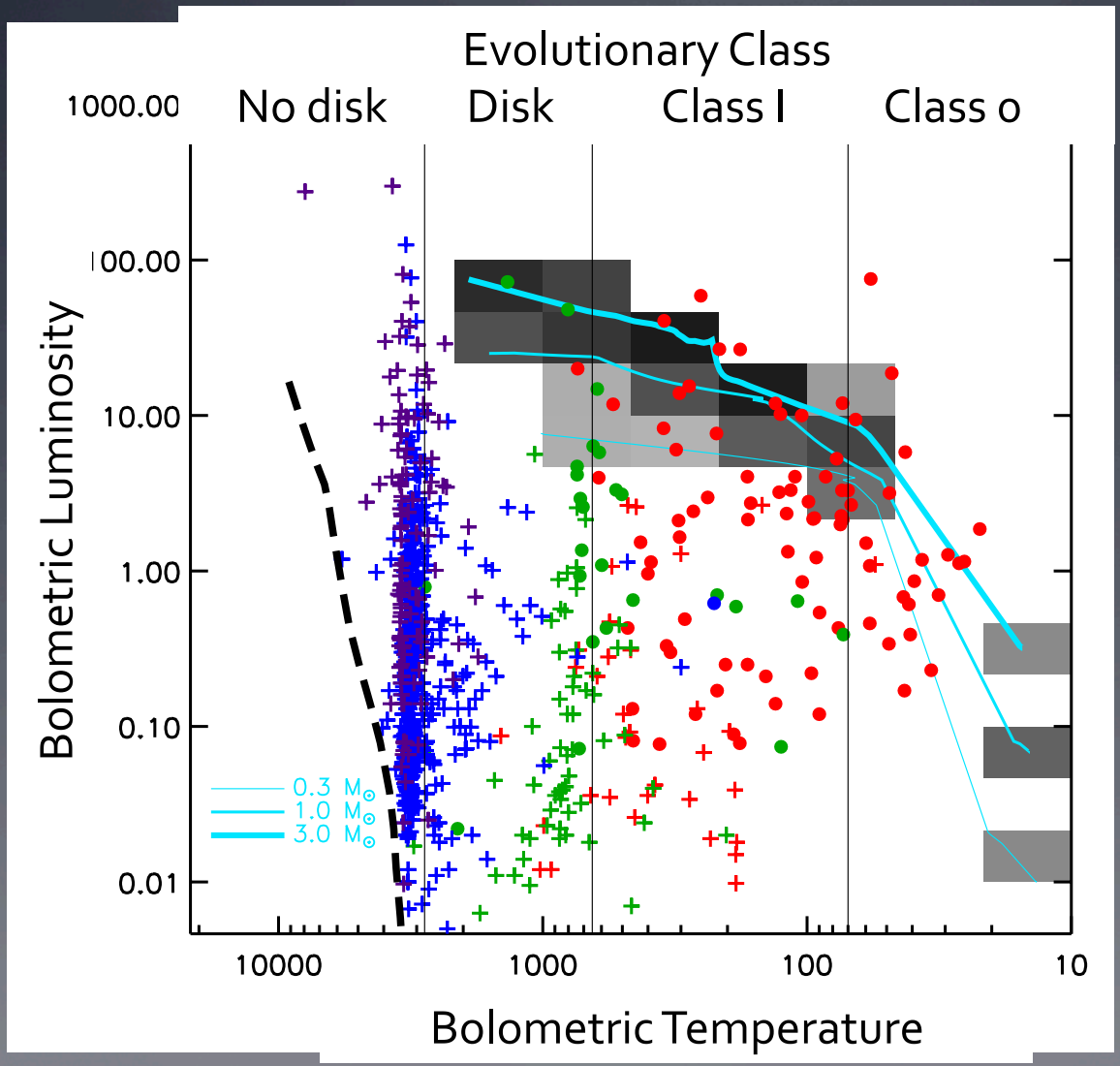




Jet shocks of YSOs
(e.g., Reipurth 1989; Hartigan+2011; Plunkett+2015)

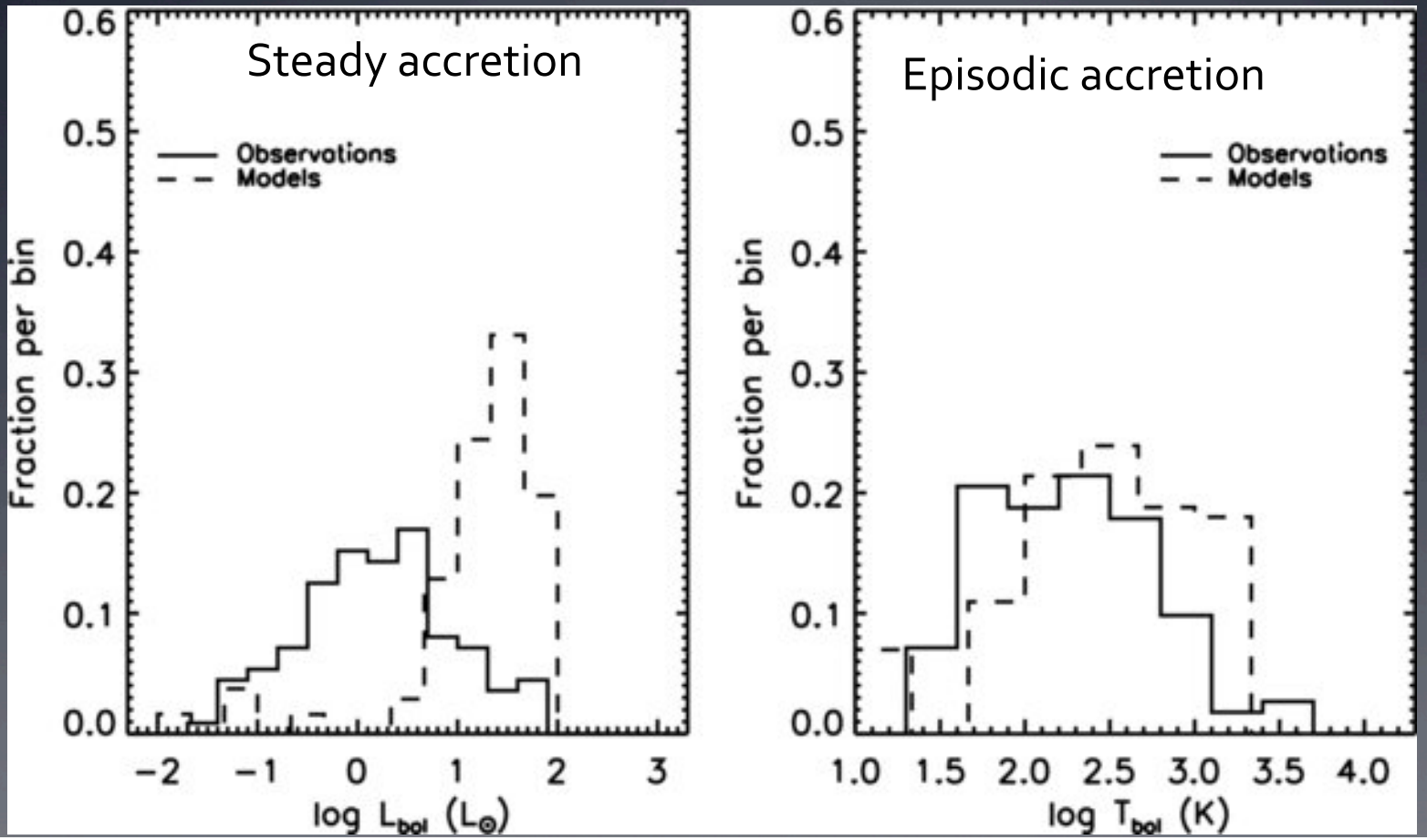
Luminosity Problem

(Kenyon et al. 1990; Dunham et al. 2009)



Episodic bursts of accretion

(Kenyon et al. 1990; Dunham, Evans, et al. 2009)

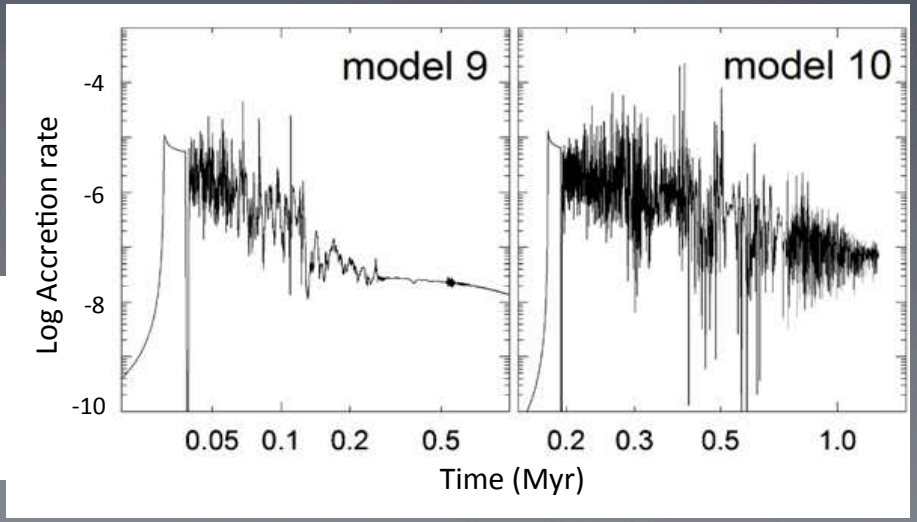


Time dependence needed; episodic accretion is likely (but not only) solution (e.g., Offner & McKee; see review by Hartmann, Herczeg, & Calvet 2016).

Causes of outbursts

- Disk instabilities (universal)
  - Gravitational, magneto-rotational, thermal
- Binarity (e.g. Bonnell & Bastien 1992, Reipurth 2000)
- Magnetospheric instabilities (D'Angelo & Spruit 2010, Armitage 2016)
- Tidal disruption of planets or alien weaponry (Herczeg+2016)

Frequency: 1 of 10^4 stars from optical (Hillenbrand & Findeisen 2015; Contreras-Pena 2019)



Models from Dunham & Vorobyov (2012)
See also, e.g., Zhu+, Bae+, Stamatellos+, Vorobyov+, Machida+, others

Namakanui Detector and the Transient Survey

- Depth: more calibrators, especially disks
  - ToO easier for bursts identified in optical/IR surveys
- Field of view: more objects! More calibrators! Higher cadence?
- Faster coverage?
  - Do rapid changes in atmosphere limit calibration?
- 450 microns? Faster = much more powerful
- Better able to achieve main science goals
  - Measure sub-mm variability as a probe of accretion instabilities in very young disks
  - Evaluate variability (episodic accretion) as explanation of luminosity problem
- Challenge: Confusion limit in young regions

Other applications related to Transient

- The variable sub-mm sky: extinction can be ignored!
  - Supernova? TDEs?
  - AGN/Quasars??
  - Stellar flares???? (coordinated for multi-wavelength opacity)
  - eta Car outbursts?
- Protoplanetary disks (primordial, debris) and proto-brown dwarfs
  - Confusion-limited in youngest regions
- Filaments
- Polarimetry: many other talks

The immediate future of Transient

- Initial survey is finished in January
  - Several papers in preparation
  - Changes on 1-2 year timescales: we need longer-term lightcurves
- We hope to continue the survey
  - Similar fields/cadence
  - Possible changes (e.g., a high-mass SF region?)
  - Need help for some improvements in primary science; also in ancillary science (e.g., disks in our very deep coadded maps)
  - Team meeting in August 2019 at NCU, Taiwan

If you would like to help guide the future of the survey, contact Doug, Steve, or me (gherczeg1@gmail.com)