Advanced Technologies and Instrumentation at the National Science Foundation

Peter Kurczynski

Astronomy & Astrophysics Advisory Committee (AAAC) Meeting

February 26, 2019

ATI through the years

- 1980's: Charge Coupled Devices
- 1990's:
  - Sub-millimeter astronomy
  - Adaptive optics
- 2000's:
  - IR detectors
  - Instrumentation (eg. KPNO, Palomar, CSO…)
- 2010's:
  - Radio/submm focal plane arrays; low frequency
  - Laser frequency combs (HPRV)

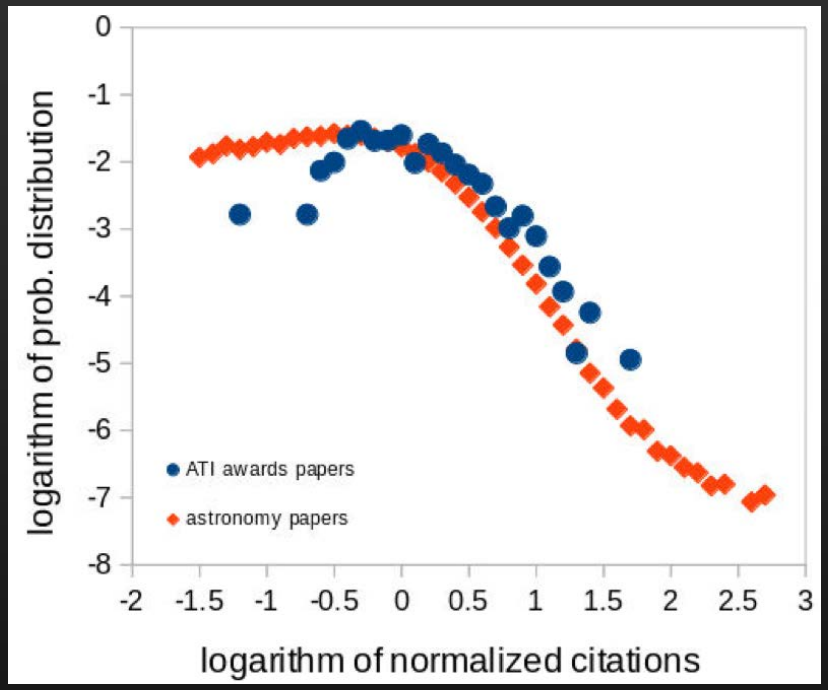
What is the *impact* of ATI?

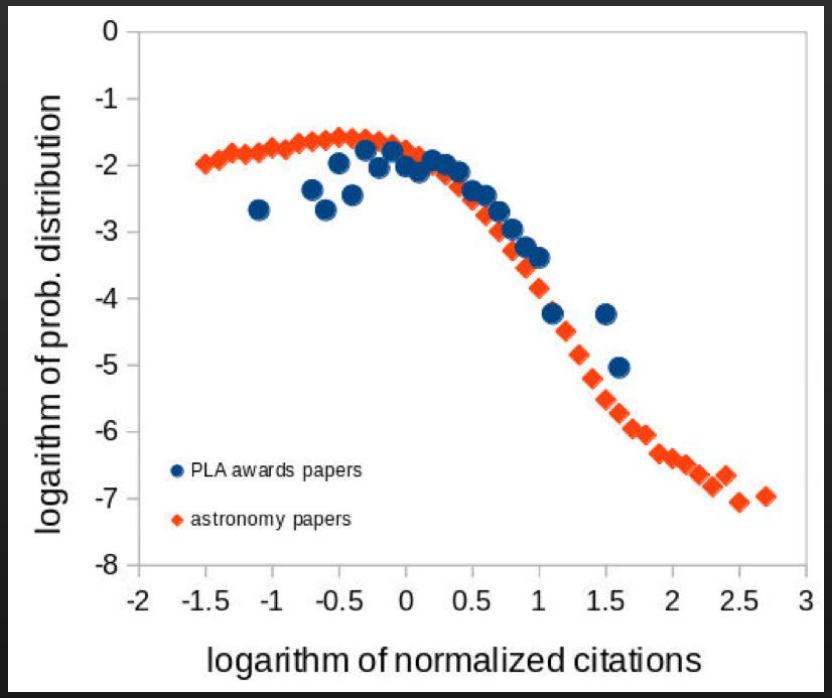
Acknowledgements comparable to Planetary Astronomy (PLA)

Acknowledgements in peer-reviewed literature	PLA	ATI
Total number of awards (1987 – 2016)	445	**496**
Acknowledged at least once	138	**216**
Acknowledged at least twice	83	**140**
Acknowledged at least 5x	35	**51**
Acknowledged at least 10x	16	**18**
Acknowledged at least 20x	3	**3**

Kurczynski & Neff 2018, SPIE 10706 (arxiv: 1809.01294)

ATI has comparable *impact* to PLA





Kurczynski et al 2019 in prep

Figures courtesy Stasa Milojevic, Indiana University

1st NSF award for LSST (2004; PI: Tyson)

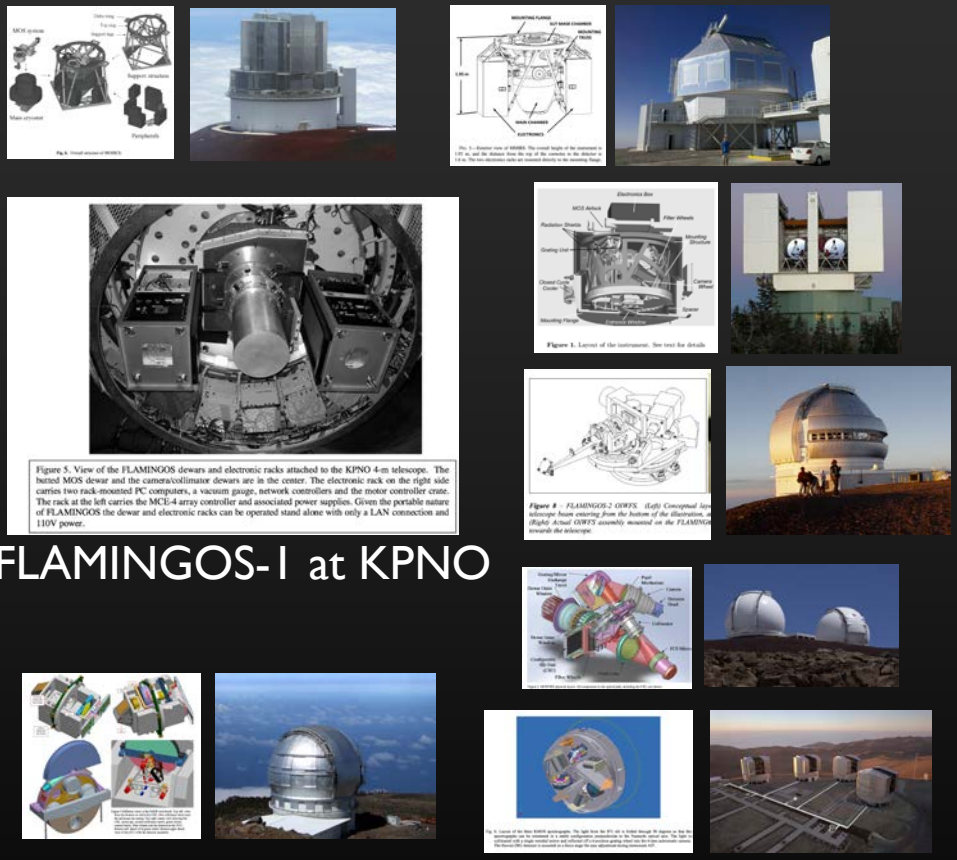
"That original ATI grant was enabling for LSST. I don't think we would have a camera now without it."

-Tony Tyson

Image: LSST Project/NSF/AURA

IR Multi-Object Spectroscopy (1997 PI: Elston)

FLAMINGOS-1 at KPNO



Instrument	Facility	1st Light
FLAMINGOS	KPNO/Gemini	2000
MOIRCS	Subaru	2004
MMIRS	Magellan/MMT	2009
LUCIFER	LBT	2009
Flamingos2	Gemini	2010
MOSFIRE	Keck	2012
KMOS	VLT	2012
EMIR	GTC	2016

EDGES – Evidence of the First Stars

Bowman, J. et al Nature 2018

EDGES media coverage

- Video: 109,000 views on YouTube
- Washington Post
- NY Times
- USA Today
- CNN
- The Guardian (UK)
- Physics World Breakthrough of the Year 2018 (Finalist)

Awaiting confirmation…

Event Horizon Telescope

Science breakthrough of the year in 2019?
– Forbes Magazine

- 22 NSF awards (2000-2018)
- $29M NSF investment
- 8 ATI awards ($8M)

Conclusions

- ATI: 30+ years of science & technology awards
- Literature impact comparable to pure science program
- It may take a decade or more to know the true impact of technology development in astronomy
- ATI solicitation now active!

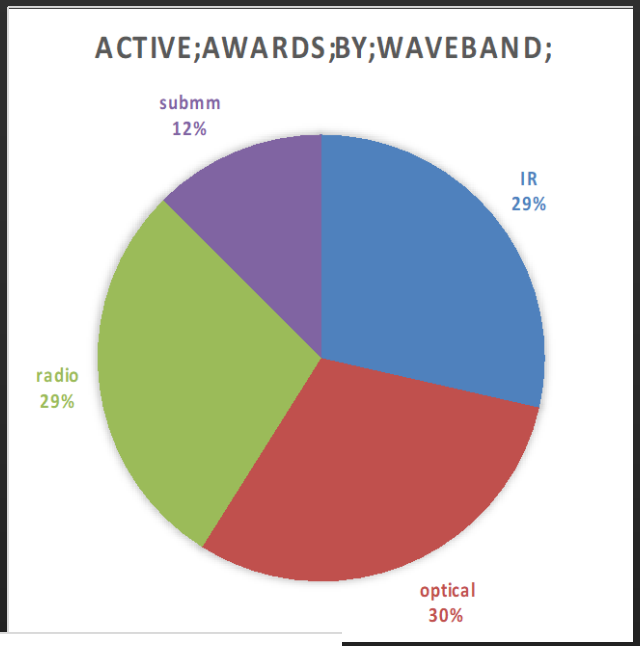
Acknowledgements & Image Credits

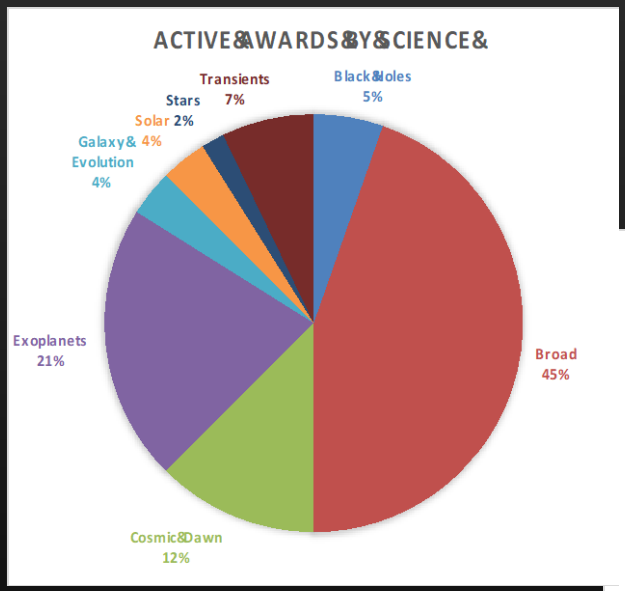
Images: Magellan Clay: Ian Czekalav (astrobites); Subaru, LBT, Keck, VLT, Gemini, GTC: Wikipedia; FLAMINGOS at KPNO: Elston+2003; MOIRCS Suzuki+2008; MMIRS McLeod+2012; LUCIFER Seifert+2002; MOSFIRE Mclean+2010; KMOS Sharples+2006; EMIR Garzon+2006. Priv. communications: Christoph Baranec, Jamie Bock, Julian Christou, Mark Chun, Kieran Cleary, Scott Diddams, Shep Doeleman, Steve Eikenberry, Neal Erickson, Shaul Hanany, Don Figer, Debra Fischer, Jian Ge, Phil Goode, Don Hall, Gregg Hallinan, Casey Law, Mike Pierce, Deqing Ren, Tony Readhead, Ray Sharples, Tony Tyson, Melville Ulmer

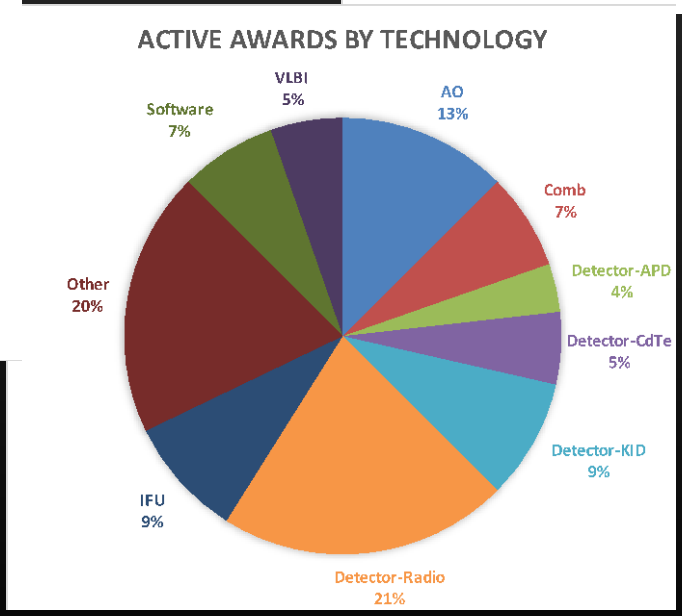
EXTRA SLIDES

Summary of Active Awards*

- Radio-optical wavebands
- Broad science & technology focus
- ~$8M / year budget



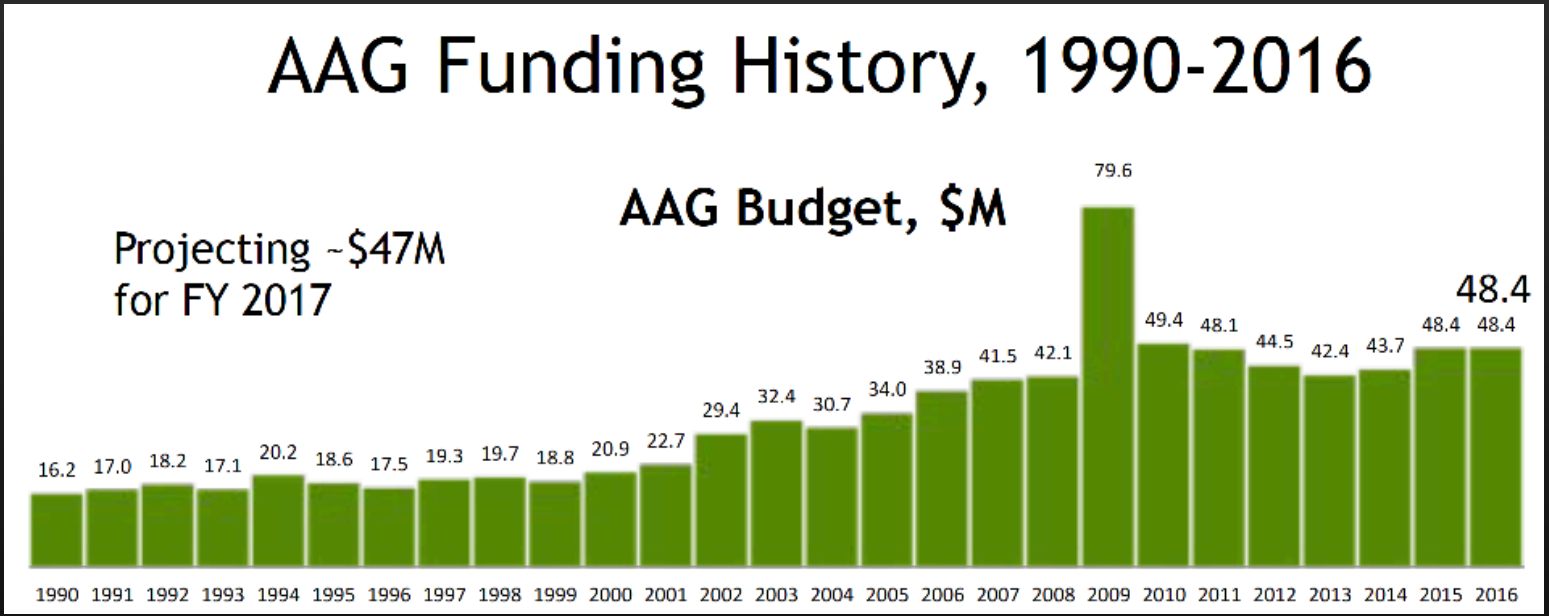




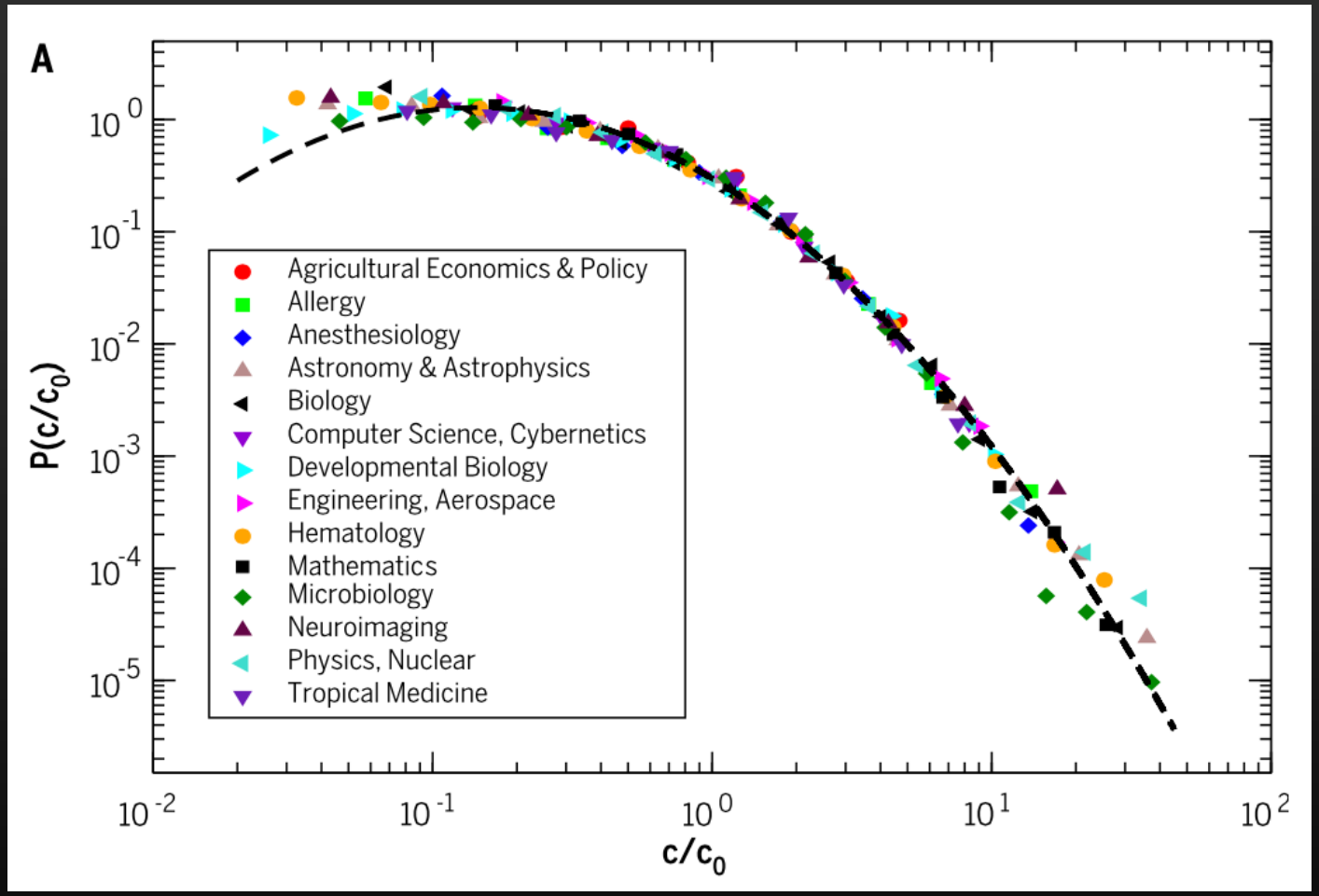
*includes FY17

Advanced Technologies & Instrumentation

- 54 active awards / $41.6M
- FY17: 9 projects / 1 conference awarded ($5.7M)
- ATI Budget: ~$8M / yr

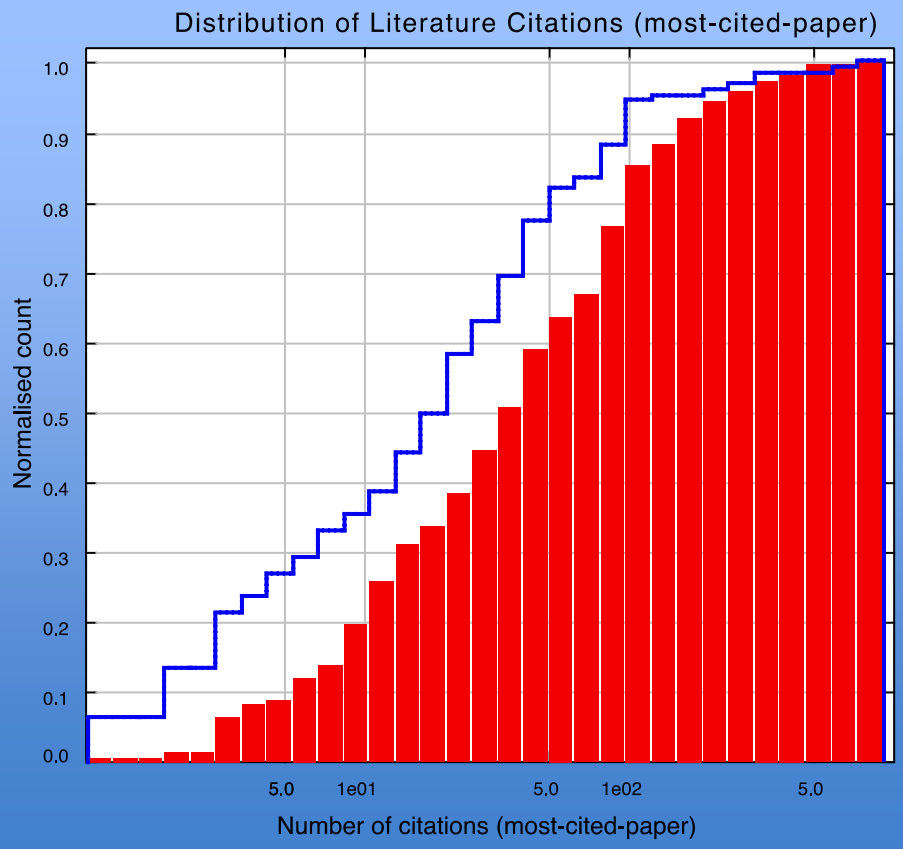


Universality of science citations



Fortunato et al. 2018, Science 359, 1007; Fig 5A

ATI: Citations of most-cited-papers



Program	Median
ATI	39
SPG	21

Impact of most-cited papers

Award (1)	PI (2)	Bibcode (3)	Year (4)	Citations (5)	Median (6)	Impact (7)
		ATI				
9413935	Readhead	2002ApJ...568...38H	2002	769	36	21.4
0096913	Carlstrom	2002ARA&A..40..643C	2002	561	36	15.6
8822465	McCarthy	1991ApJS...77..417K	1991	495	25	19.8
0904607	Townsend	2013ApJS..208....4P	2013	489	9*	54.3*
9203336	McCarthy	1993AJ....106..773H	1993	420	27	15.6
		PLA				
9120599	Begelman	1994ApJ...421..153S	1994	860	27	31.9
8857365	Wisdom	1991AJ....102.1528W	1991	675	25	27.0
9530590	Heiles	2003ApJ...586.1067H	2003	341	28	12.2
9973057	Tedesco	2002AJ....123.1056T	2002	310	36	8.6
9714275	Lin	2001ApJ...548..466B	2001	249	31	8.0

Limits of literature assessment

- Type I error (false positive): <15%
  - from individual inspection of 33/216 most cited ATI publications.
  - No false positives found.
- Type II error (false negative):
  - non-ADS publications: not in ADS database (automated search)
  - delinquent publications: do not (fully) acknowledge award

Limits of literature assessment …

- Widely acknowledged awards may be impactful
- Impactful awards may not be widely acknowledged

Award ID (1)	PI (2)	Acknowl. (3)	Most Cited (4)	Citations (5)
0906060	Baranec, Christoph	31	2014ApJ...791...35L	79
0705139	Ge, Jian	27	2011ApJ...728...32L	29
1006676	Mahadevan, Suvrath	22	2014Sci...345..440R	68
9731180	Elston, Richard	5	2003AJ....125.2029M	112
0441069	Tyson, J. Anthony	1	2014JInst...9C7010T	0

* Number of peer-reviewed publications that acknowledge this award

ATI trains instrument builders

- Award size and scope
  - Large enough to have substantial impact
  - Small enough for early-career investigator
- Awardees become leaders
  - PECASE and CAREER awardees
  - Large projects

ATI Program: current status

- Program currently on hold
- New solicitation in progress
- Expected return in FY19

- **Joint NSF/NASA Principal Investigators meeting**
  - planned for September 2018
  - Active ATI investigators: See me for details!

- See here for program info:
  https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5660

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9731180	**Elston, Richard**	5
0441069	**Tyson, J. Anthony**	1

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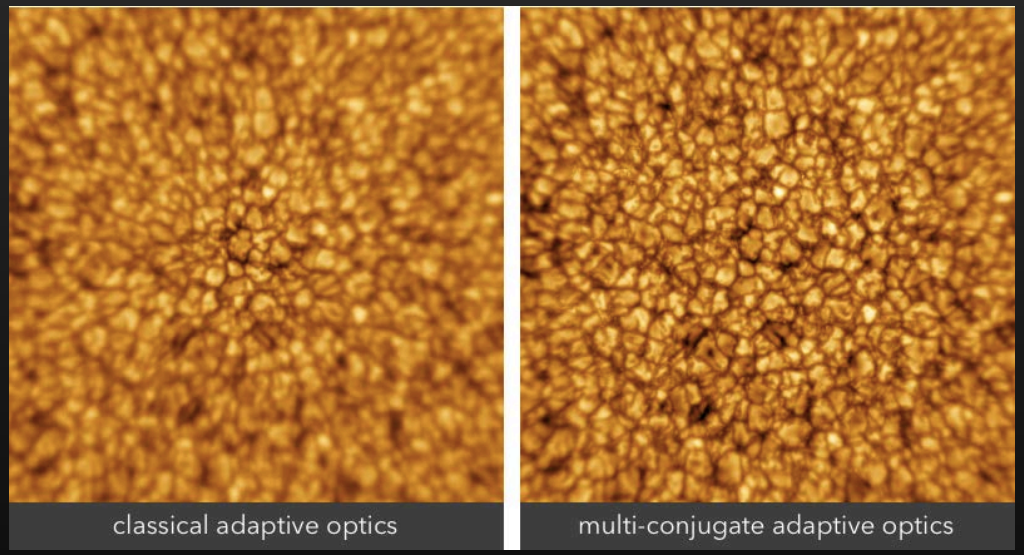
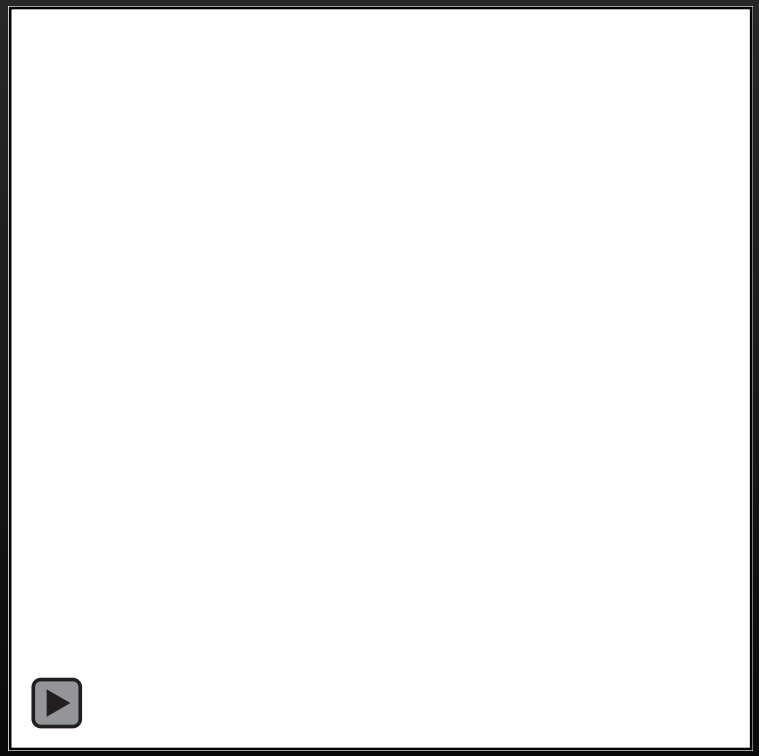
Multi-Conjugate Adaptive Optics (MCAO)

- MCAO under development at Big Bear Solar Observatory (BBSO)
- Uses 3 deformable mirrors to compensate for turbulence at 3 different heights in the atmosphere
- NSO personnel leading the effort
- NSF funded through AST-ATI award
- Pathfinder for DKIST next-generation AO system





What is the impact of ATI?

- automated search for grant acknowledgement in ADS
- compare with planetary astronomy program (PLA)

Acknowledgments (1)	ATI (2)	PLA (3)
20	3	3
10	18	16
5	51	35
2	140	83
1	216	138
Total	496	445

Kurczynski & Neff 2018 SPIE (arxiv:xxx)

Case study: LSST detectors (2004 Award PI: Tyson)

- detector design study; 1st NSF award for LSST
- crucial time in project development

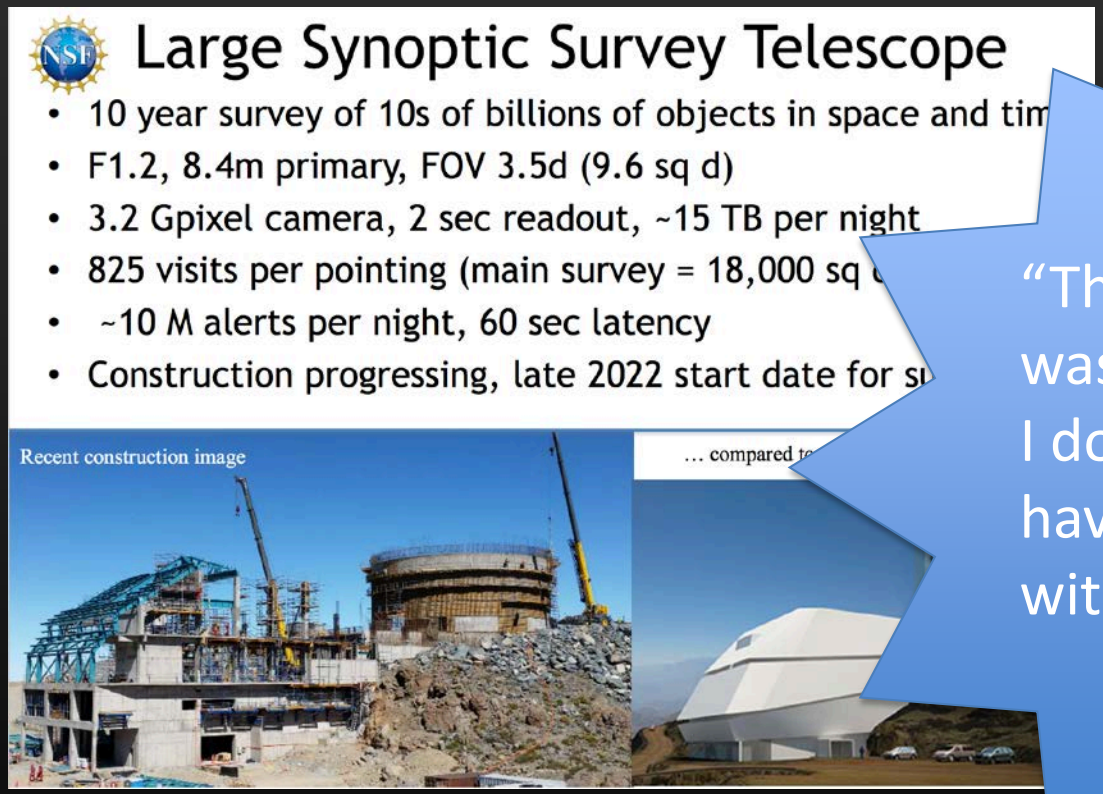


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Image: LSST Project/NSF/AURA