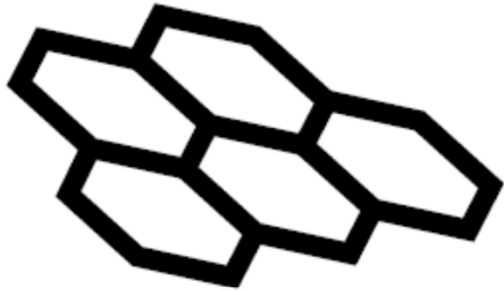


The Thirty Meter Telescope International Science Forum Kyoto 2016



TIO: A Powerful New International Astronomical Partnership



TMT

30 m 望遠鏡

三十米望远镜

तीस मीटर दूरबीन

Thirty Meter Telescope

Télescope de Trente Mètres

Why we are building TMT

- Completely new Science
- Current Science beyond current capabilities
- New technology for vastly increased performance
- New engineering for cost reduction: not simply more for more

The Grand Themes

- ***Physics of the Universe:***
 - *Big Bang physics*
 - *Dark Matter*
 - *Dark Energy*
- ***Origins of Structures in the Universe:***
 - *Galaxies*
 - *Stars & Planets*
 - *Planets and Life*
- ***DISCOVERY***

An unprecedented step

- Natural seeing science D^2
- AO science D^4
 - About a factor of 100 gain
- XAO/ crowded field science $\sim D^7$
 - About a factor of 5000

AO gain Analogy: Tokyo to Kyoto travel time:

Walk: 10 days

Nozomi: 0.1 day

8m to 30m AO speed

Nakasendo Trail, Japan



The 2030 telescope landscape

- JWST at end of lifetime
 - Infrared images at 30th magnitude and deeper
- ALMA full size mature instrument
 - Milli-arcsec images
 - Molecular lines at all redshifts
- LSST 5+ year data available
- GAIA astrometry revolution
- Pre SKA operating, Euclid/WFIRST
- Deep, all sky, multiband, transient sky images available. Spectroscopy needed!

TMT of the future

- TMT is a superb telescope
- Has very basic first light instruments
- Has a very good AO system, but correction will need to be increased
 - In wavelength
 - In field of view
 - In Strehl ratio
- New instruments required!

Instruments will improve dramatically over next 20 years

- Where are the best science opportunities?
 - The TMT Forum is extremely important
 - Move from walking to Nozomi speed thoughts.
- Where are the greatest technological gains?
- Requires ideas from theorists, observers, instrument scientists (and funding sources)
- Requires considerable thoughtful debate
 - The TMT forum is extremely important to inform the SAC of a wide range of great science.

The route to the Prize



- 1915+ Einstein GR theory, Λ
- 1993
 - Phillips relation calibrating SNe Ia Luminosity
 - Keck I begins science operations
 - Wide field cameras on several 4m
 - Two teams start work
- 1998: Accelerating universe announced
- 2011: Nobel prize
- **Not predictable!**

TMT vs ESO

- IMF Economy GDP
 - EU 19T US\$
 - US, Canada, Japan, China, India: 37T US\$
- ESO has developed a powerful organization
 - E-ELT 2024-2027
 - TMT 2027
- TIO needs to do at least as well
 - High quality telescope(s) assured
 - Many excellent astronomers
 - Stable finance and quality management
 - Need to work together...



An Unbalanced Project



Past Mistakes of *others*

- Inadequate telescope commissioning
 - The telescope is key to everything
 - Needs ongoing tuning
- Inadequate or excessive operating funds
- Poorly managed key projects
- Poorly selected key projects
- International “silos” with little in common
- Lavish, inefficient, 2nd gen instruments
- Slow to acquire 2nd gen instruments

Temporary Complications

- Have lost access to site in Hawaii
 - Plan construction restart April 2018
 - Reapplying for Hawaii permit
 - Considering alternative sites
 - Site physics understood:
 - High is good, +4000m for MIR, UV
 - Hadley cell (+/- 20-25 latitude) dry, laminar air (trade winds)
 - Coastal to minimize mid layer turbulence
- Site and timeline affect instrumentation
 - Makes science input even more important
 - Wisdom in making choices

TMT: Balance ISDTs and Forum are key!



