Astrobiology Science & Technology for Instrument Development (ASTID)

Michael New

- Enables future mission instruments for the exploration of planetary bodies in the search for prebiotic chemistry, habitable environments (past or present), biomarkers, and possibly life itself.

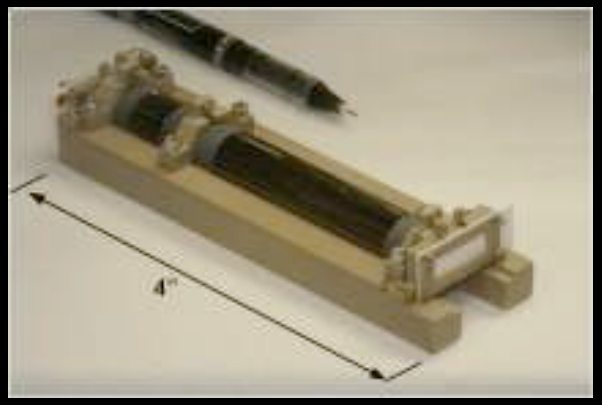
- 70 instrument-development tasks at US universities, research institutions, Federal labs, and NASA Centers.

ASTID 2009

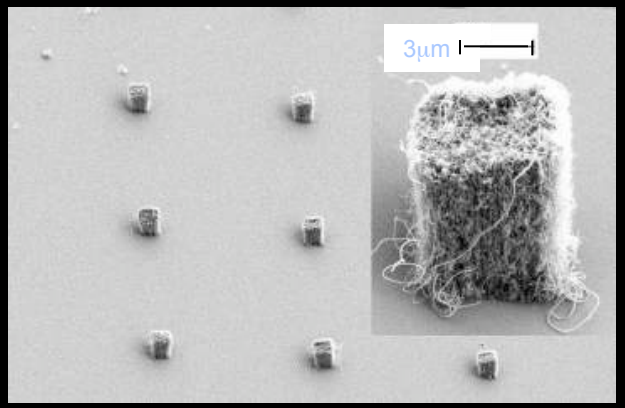
- Program funds development of instruments, from TRL 1 to 6
- 16 activities receiving PY09 funds
- Refocusing program on 3 major areas:
  - Sample acquisition, processing & handling
  - Isotope measurements (ratios, geochron)
  - Micro- and Nano-fluidic organic analytical systems (lab-on-a-chip)
  - Other areas as proposals warrant

Mini/Micro Reflectron Time of Flight M/S

Paul Mahaffy, Goddard Space Flight Center

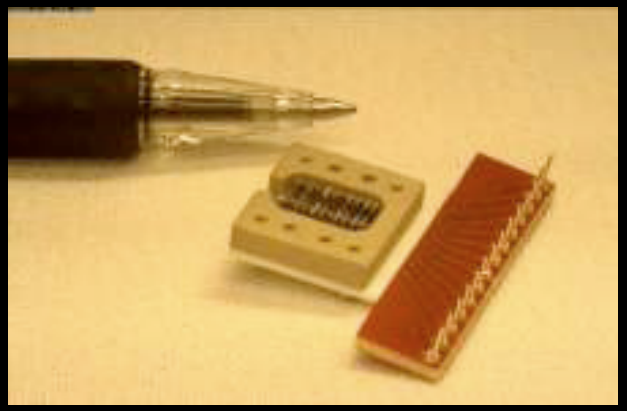


Assembled 50g (!) TOF M/S prototype ready for testing.



Microscale patterned CNT Field emitter substrate

Micro-leak valves for front end processor

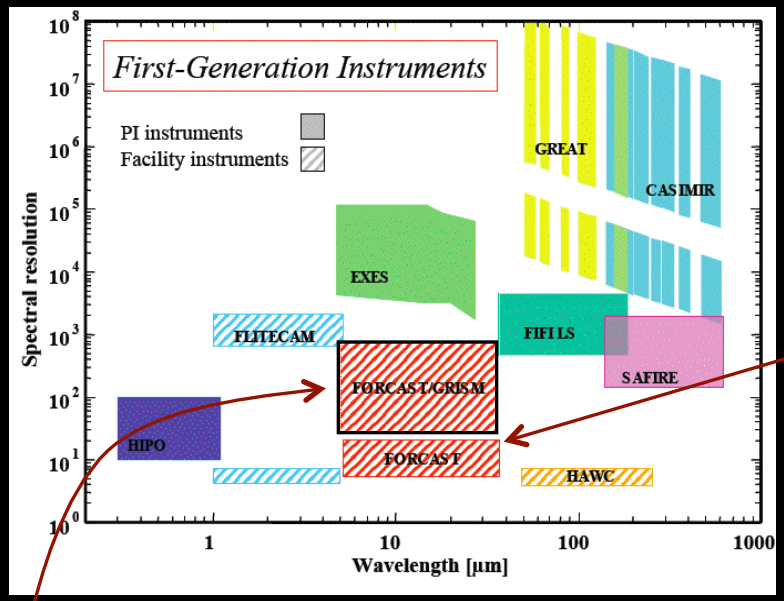


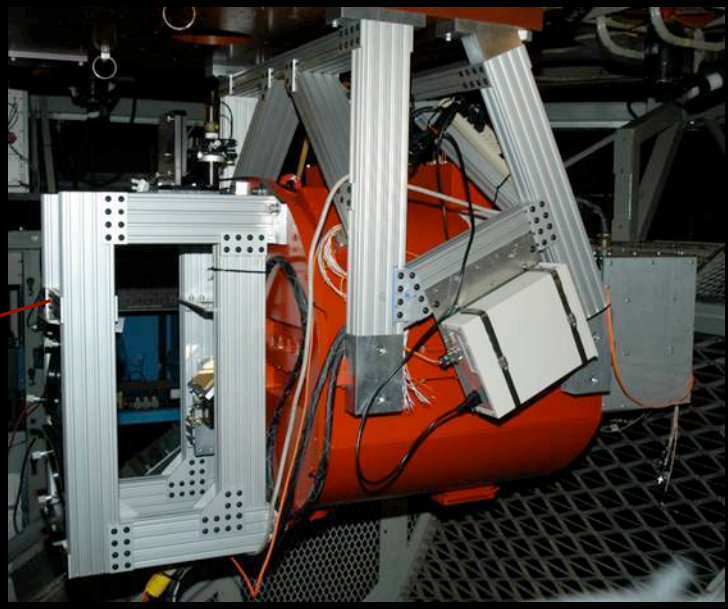
Integrated MEMS ion lens

Multi-channel plate ion detector.

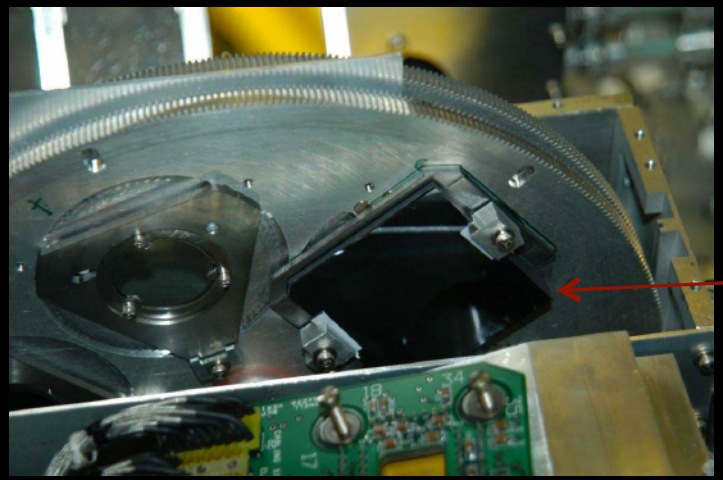
Enabling Astrobiology on *SOFIA*

Kim Ennico, NASA Ames





Area of greatest astrobiological interest: organic molecules

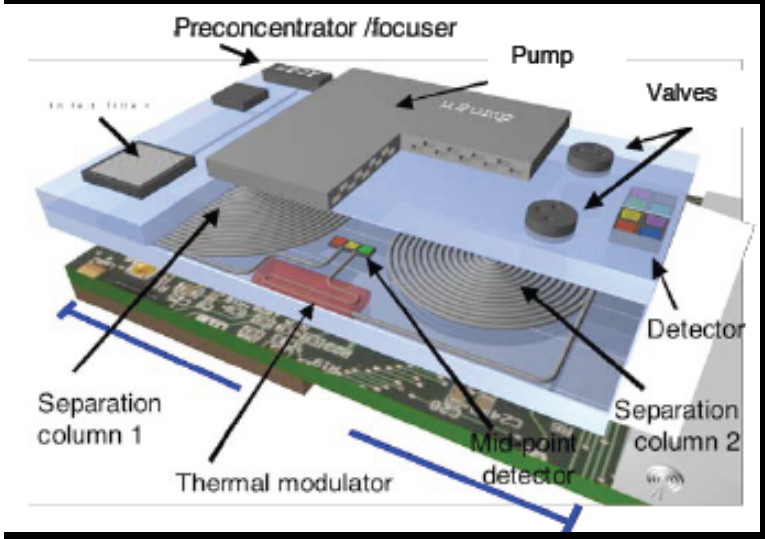


FORCAST, the **F**aint **O**bject Infra**R**ed **CA**mera for the **S**OFIA **T**elescope, installed in a test environment. *It's the first-light instrument on SOFIA starting engineering observations summer '08.*

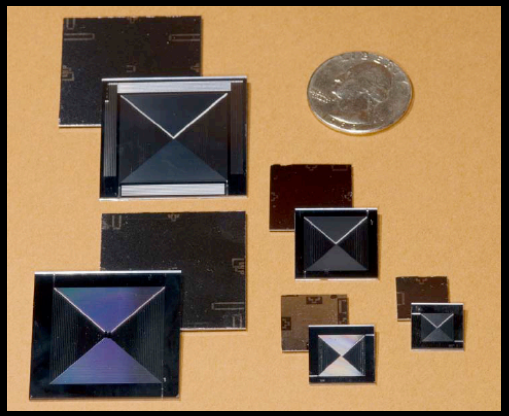
One of the "grisms" (prism + grating), developed by this grant, mounted in the FORCAST filter wheel (standard filter to its left). It will cheaply turn the imager into a medium resolution mid-IR spectrometer.

Microscale GC x GC for Characterization of Complex Mixtures

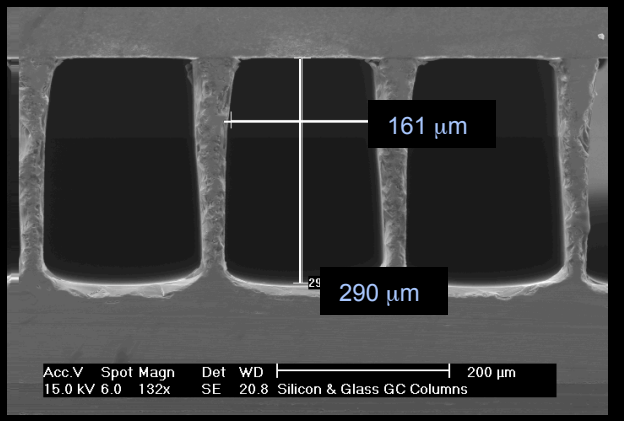
Kensall Wise, University of Michigan



Overall instrument concept

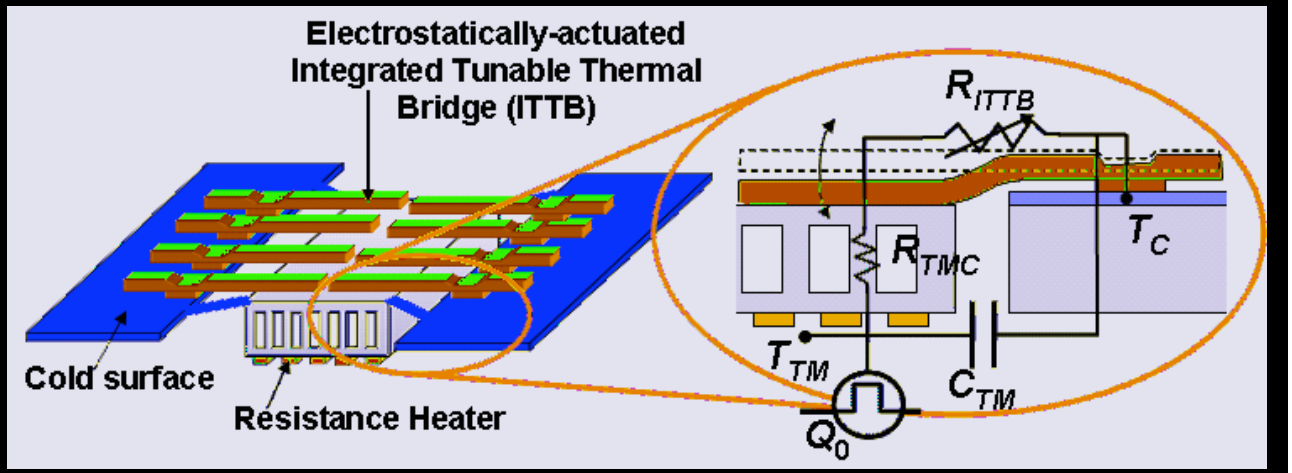


Micro-fabricated glass-silicon columns (lower left column is 3m long!)



Cross-section SEM view of a column.

Completed design of "thermal modulator" (to be fabricated this year).



ASTID goes to Mars

- Of the instruments selected for Mars Science Laboratory, both analytical instruments have ASTID heritage:
  - CheMin: x-ray diffraction/x-ray fluorescence for definitive mineralogy
  - SAM: GC/MS + TLS for isotopes (H_2, CH_4, CO, CO_2, OCS, H_2O_2)
- Further development is needed, and future “rides” in the standard mission set are hard to predict
  - Discovery, New Frontiers, Flagships, and Missions of Opportunity are potential targets

Astrobiology Small Payloads

Programmatic Actions to Implement activity are all scripted:

- Develop instruments and mission concepts under the umbrella of the existing ASTID program (ROSES-07 Amendment released); integrate into existing spacecraft designs if practicable under ≤$300K per year funding per task
- Fly missions under PSD Mission of Opportunity funding (SALMON AO, Spring 2008), providing access to recurrent MoO platforms (e.g., Minotaurs and other small launchers) and as secondary payloads on higher capability missions (e.g., Atlas V, Delta IV, Soyuz/Bion) as available
  - Partnership with ESMD may be developed to provide a "one-stop" approach for small payloads that include gravitational and space biology efforts (ESMD is included in SALMON)

Funding Anticipated/Required:

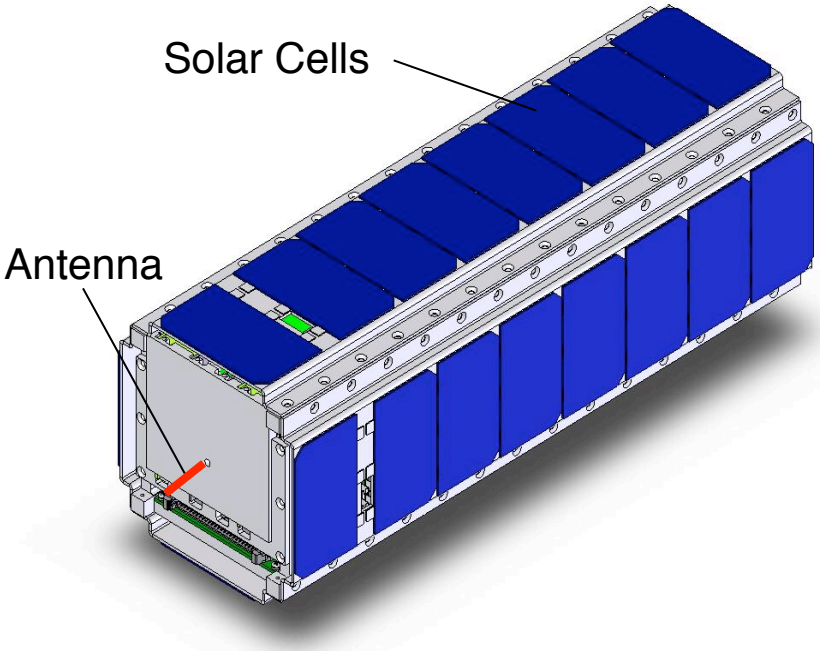
- ASTID funding allocation of $2M to $3M per year; competition-dependent and with a sustaining engineering capability at ARC
- SALMON / MoO funding of $500K - $1,000K^{+} per flight opportunity; payload dependent; competition rules! (with ESMD)
- Proof of concept test to be accomplished with a "facility-class" small payload, including a competed science team

O/OREOs Satellite

Organism/ORganic Exposure to Orbital Stresses

Exposure experiments (organics, organisms) to space environment with on-orbit monitoring/ analysis (can vary solar exposure amount, quality, and timing) using internal UV (or other) Raman

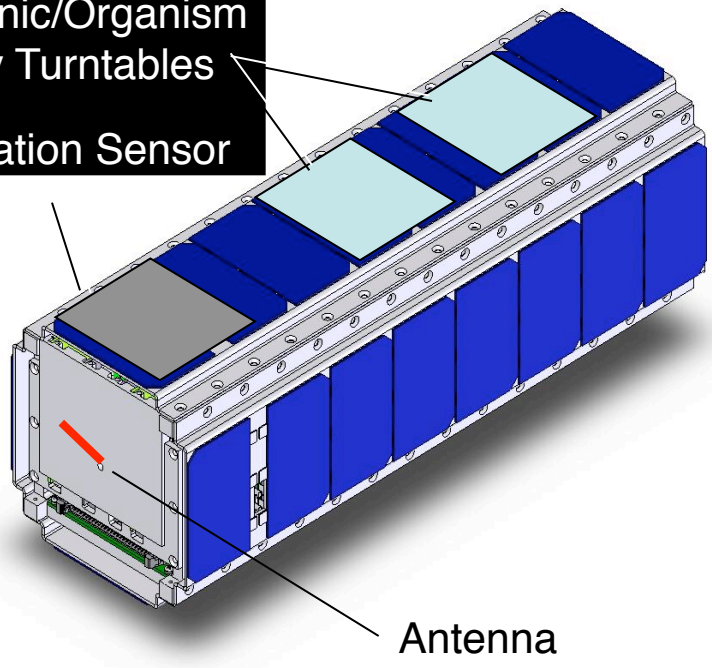
"Top" Side



"Bottom" Side

Organic/Organism Array Turntables

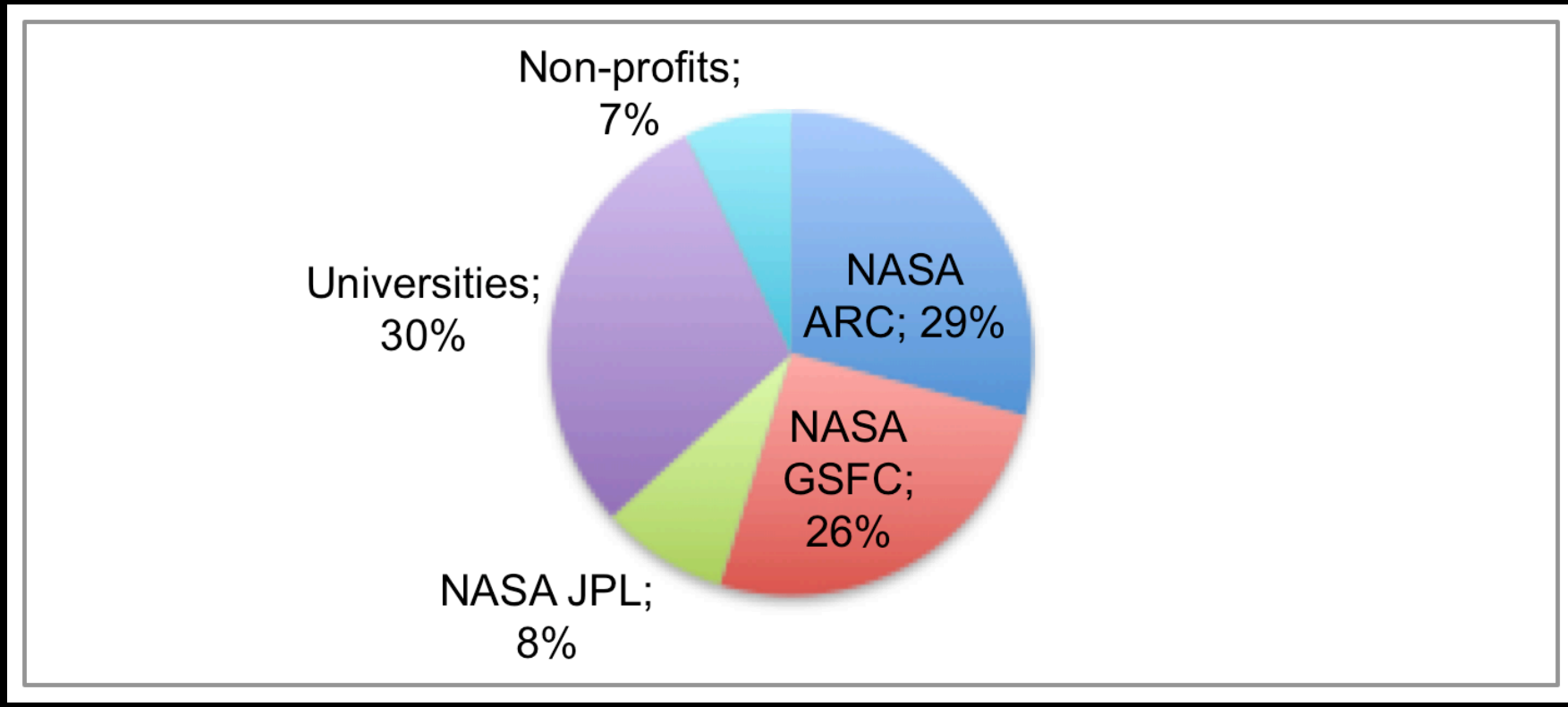
Irradiation Sensor



Spacecraft can be naturally tumbling, or may provide micro-pointing capabilities, if available.

Mission length is determined by organic exposure times desired.

Breakdown of FY09-funded ASTID Tasks by Implementing Organization



Astrobiology Science and Technology for Exploring Planets (ASTEP)

Mary Voytek (2001)

- Promotes scientifically-driven robotic exploration of extreme environments that are analogous to suspected habitable environments on other planetary bodies

- Goals: expand the known limits to life on Earth, develop methodologies for detecting past and present life, and learn how to explore a rugged, novel environment while meeting astrobiology science objectives

- 22 science-driven field campaigns and/or advanced instrument projects based at US research institutions, universities, and NASA Centers.
- 7 activities receiving PY09 fund

Some ASTEP Attributes

- Instrument suites for in situ identification and analysis of biomarkers *(prove them in the field!)*;
- Long-term and in-depth characterization of life-supporting environments, as well as non-life-supporting environments *(compare with space environments)*;
- Integration of science instrument suites with mobile platforms (rovers *& humans*);
- Autonomous instrument deployment and placement (does it *really* work?);
- Autonomous recognition of unexpected science phenomena (always difficult even with humans in-the-loop);
- Self-contained mobile science systems (develop, test, apply);
- Mobile science platforms (develop, test, *trust*); and
- Sample acquisition systems *(work? clean enough?)*

Analogue Sites for Science and Exploration

- Astrobiology has helped develop analogues for extraterrestrial and early Earth environments, e.g.,
  - Yellowstone: hot-spring organisms and taphonomy
  - Rio Tinto: high acidity organisms and sulfide-rich ecological settings
  - Lake Vaida, Lake Bonney, etc.: Europa and early Mars
  - Atacama Desert: Mars
- ESMD & SOMD looking to develop their own set of analogue sites for astronaut surface operations
  - Beginning to work with ESMD to piggy-back astrobiology research at ESMD's sites, when established (call for proposals issued)
  - And to piggy-back ESMD activities at ASTEP sites, now
- Program now pursuing "official" interaction with CSA to provide astrobiology involvement in Canadian analogue missions (ESMD and SOMD may follow)