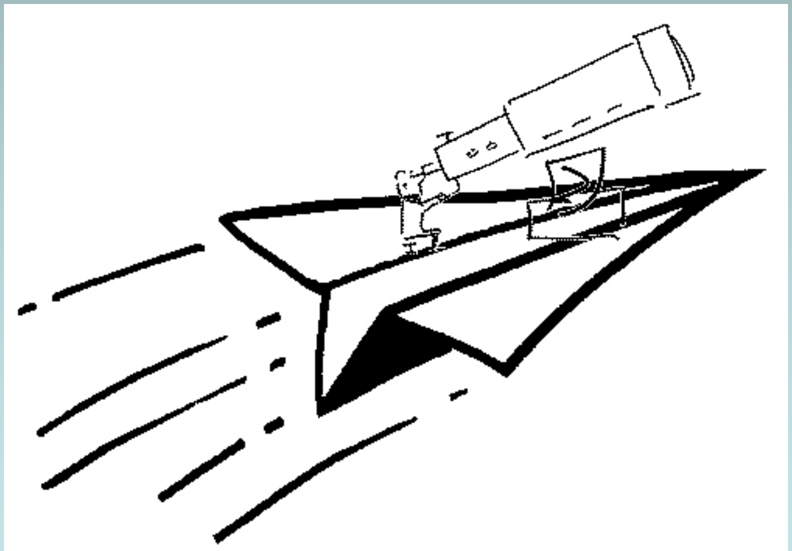
Airborne Astronomy

Launching Astronomers into the Stratosphere

Dan Lester
University of Texas



Considering NGSR, note the path blazed by airborne platforms for doing hands-on space science.

NRC/SSB 2007 "Building a Better NASA Workforce"

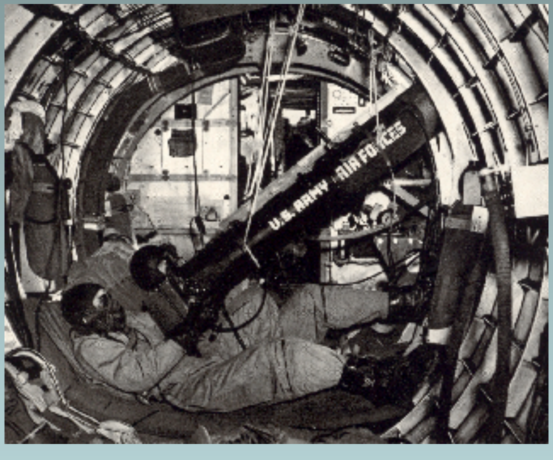
"… there is ultimately no substitute for hands-on training"

What does spam-in-the-can get you?

- **Real-time decisions**
- **Responsiveness**
- **In-situ instrument adjustment**
- **Thorough performance monitoring**

Lifting people into the upper atmosphere to do science has a long history!

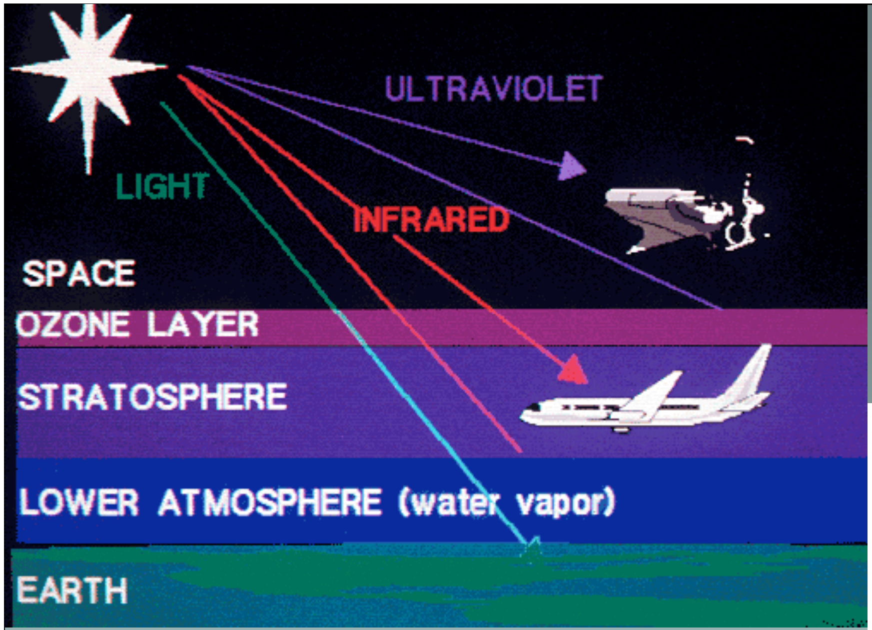
MANHIGH - 1950s balloons to 30 km

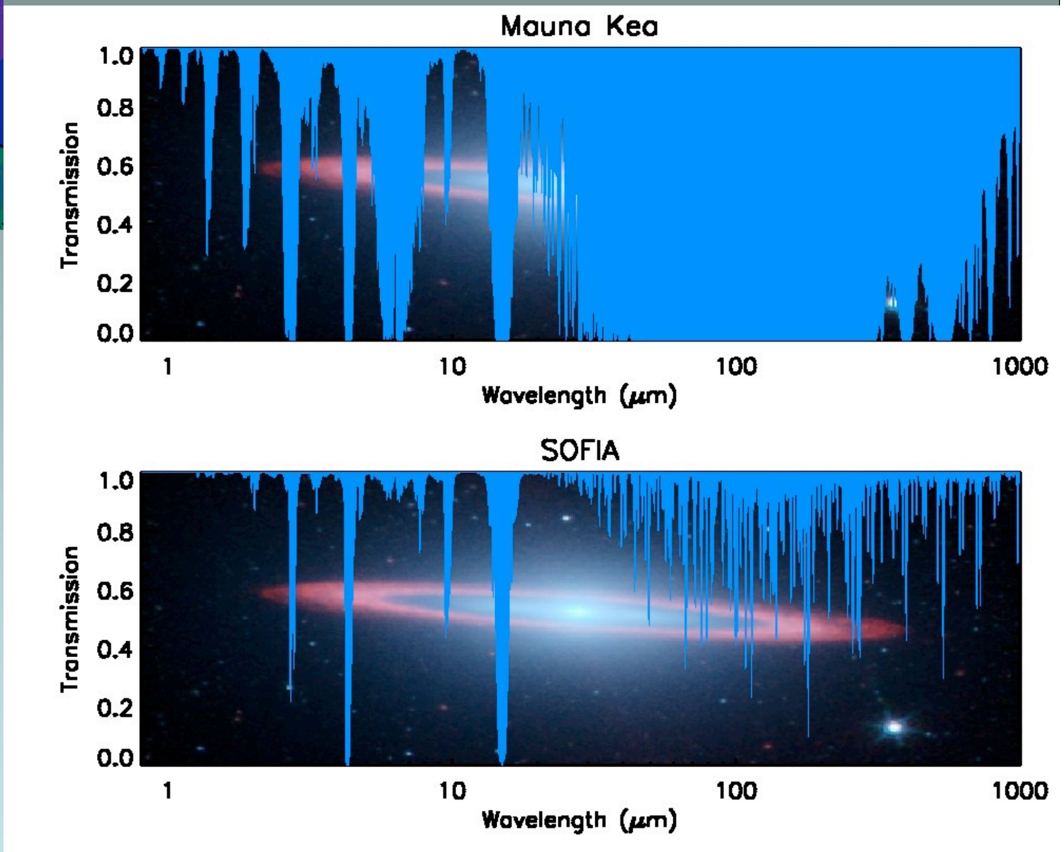


Eclipse chasing in B-29, May 1947

Alan Stern with SWUIS on an F-18

Airborne Astronomy





Stratospheric sky largely transparent in optical and IR.

Routine access to clear skies, at desired times and places.

Large telescopes and cutting edge instruments.

The first airborne astronomy with a telescope was done by G. Kuiper in a Convair 990 (“Galileo I”) in the 1960s

Gyro stabilized 30cm telescope at 12 km altitude

- **map of infrared solar spectrum**
- **lack of water in Venusian clouds**
- **CH_4 in Uranus & Neptune**

The LearJet Observatory took an observatory-class infrared telescope into the stratosphere

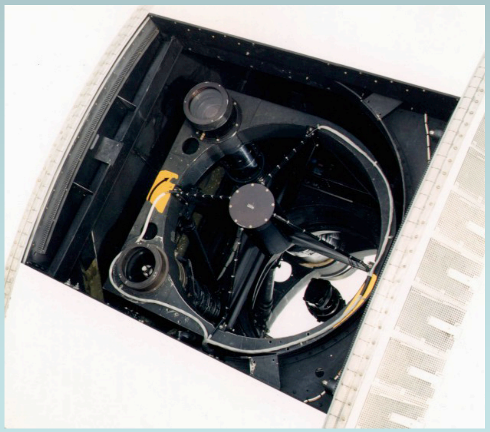
- extra-solar far-IR ionic structure lines
- submillimeter solar limb brightening
- spectroscopic study of lightning
- self-heating of Jupiter and Saturn
- studies of star formation at spectral peak
- sulfuric acid in Venusian atmosphere

30 cm, open-port telescope with chopping secondary
14-15 km operational altitude
commissioned in 1968, more than 70 papers since

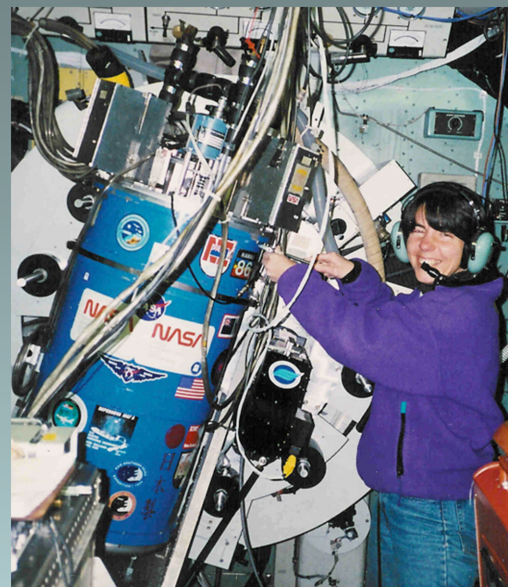
The Kuiper Airborne Observatory (KAO) made airborne astronomy a tool for the community at large

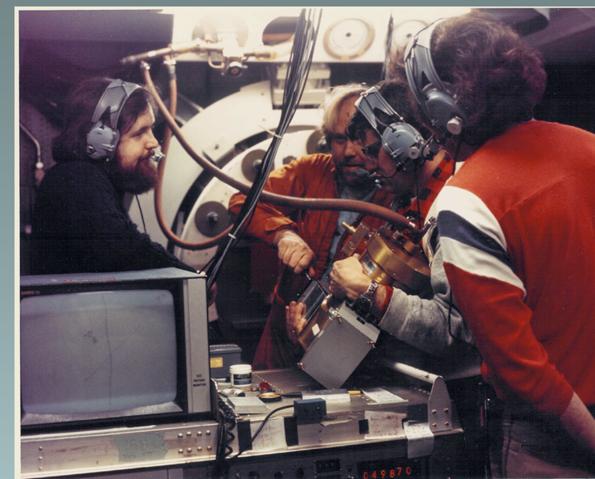
- rings around Uranus
- key combustion products in SNe
- black hole at Galactic Center
- ultraluminous galaxies
- water in Jupiter
- dust in galaxy energetics
- assay interstellar cloud coolants
- fragmentation in star formation

91 cm, open-port telescope
13-14 km operational altitude
commissioned in 1975, retired in 1995
50 instruments, 33 instrument teams
~1000 refereed papers, ~ 50 PhD theses
active EPO outreach to K-12 teachers



But what made KAO special was what went on inside …



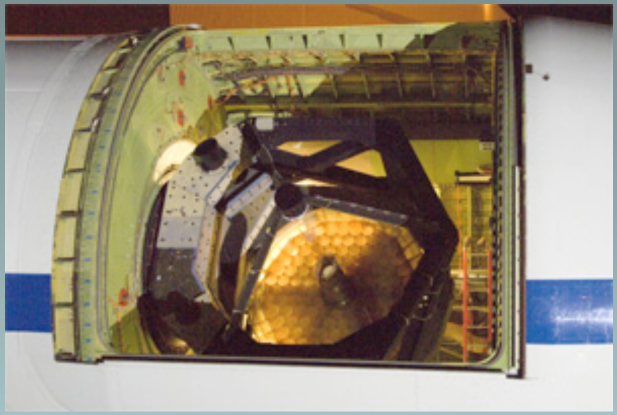


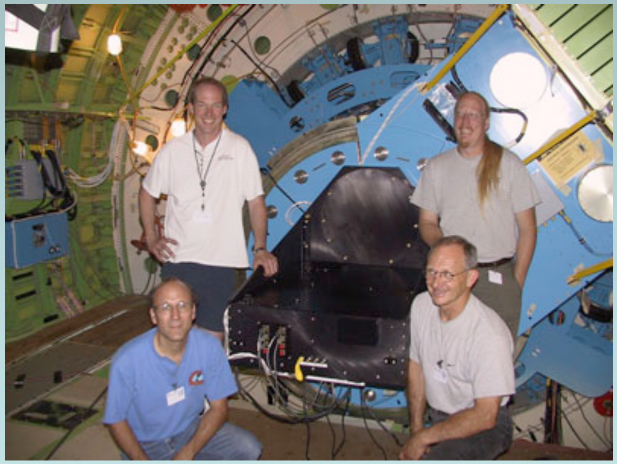
hands-on
space science

The Stratospheric Observatory for Infrared Astronomy (SOFIA) follows in the legacy of these observatories

SOFIA will offer hands-on access to space science for a new generation, with a huge 2.5m telescope!

~100 8-hour flights per year
8 first-generation instruments
partnership with Germany





Now, astronomy needs <u>aperture</u>

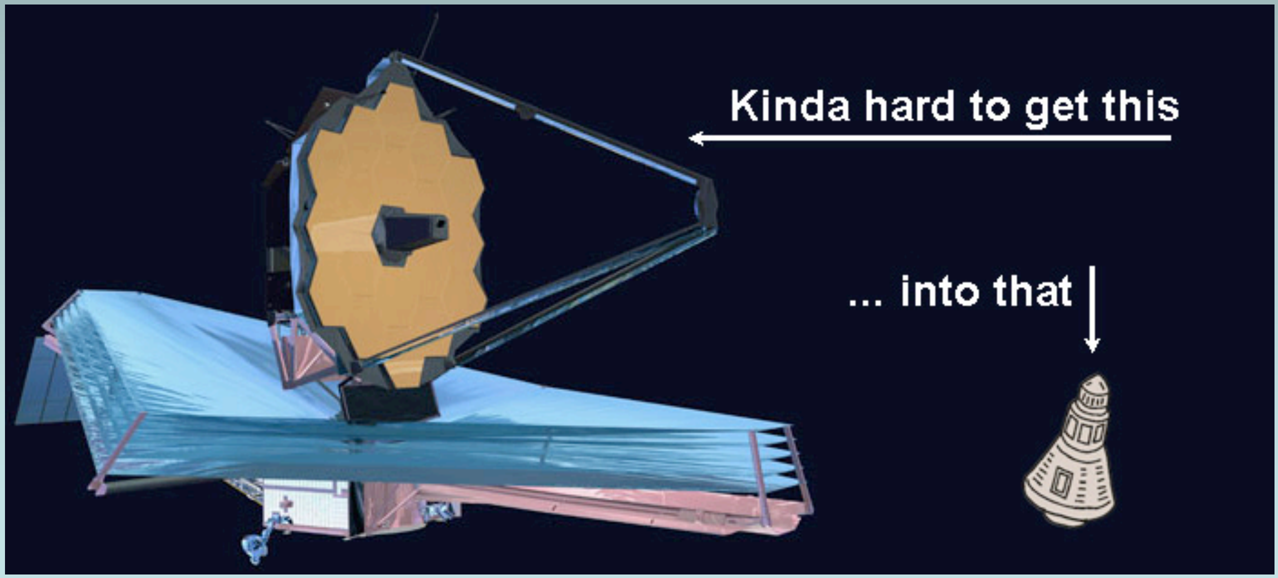
- astronomical research is almost always <u>flux limited</u>

  ⟶ large aperture

- infrared astronomy is almost always <u>diffraction limited</u>

  ⟶ large aperture

So many kinds of astronomy will not be appropriate to suborbital space platforms. But some still might …



Nevertheless, re hands-on space science, airborne astronomy and NGSR can learn a lot from each other!

- how to articulate the value of in-situ humans
- how to validate higher-risk/payoff space instrumentation
- how to train the next generation of space scientists
- how to bring excitement of hands-on work to the public

Value metric for NGSR? - At/$ often assumed for astronomy
Airborne astronomy not exceptional by that metric
NGSR would fail dramatically by that metric!

Is science output $\propto$ observing time?
(We don't believe it necessarily is!)

Questions for NGSR proponents I

(and how airborne astronomers would answer them)

• **Obligation for community support? How?**
  - “facility instruments” with “guest” science
  - access to “targets of opportunity”
  - specific inclusiveness of non-instrumentalists
  - data archiving

• **Need for and extent of centralized organization?**
  - “Science Center” with active, funded researchers
  - standardization/test equipment/training
  - science-driven operations

• **Responsivity to partnering opportunities?**
  - international (ITAR-compliant, e.g. other space agencies)
  - other U.S. agencies (e.g. NSF, NIH, DOI, DOE, Commerce)

Questions for NGSR proponents II

(and how airborne astronomers would answer them)

- **Optimal program selection? Who, and what flies?**
  - **peer review guided by NASA science strategic plan**
  - **instrument support that is space mission-enabling**
- **How to train next-generation space scientists?**
  - **students get to fly, take management responsibility**
  - **significant mission design involvement**
- **How to best build technology base?**
  - **program investment in new instrumentation**
  - **validation of lower TRL, mission-enabling technologies**

Next-Generation Suborbital Research should consider the many lessons learned by airborne science communities in how to best do <u>hands-on space science</u>.

We welcome that dialog.