

SOFIA SCIENCE TRACEABILITY MATRIX

Decadal Science Questions †	Key Measurements	SOFIA Instruments	SOFIA Observations
HOW DID WE GET HERE? COSMIC ECOSYSTEMS			
F-Q1: How do star-forming structures arise from, and interact with, the diffuse interstellar medium?	[C II] 158 μ m, [O I] 63 & 145 μ m, light hydrides, kinematics & Far-IR polarimetry	GREAT, FIFI-LS, HAWC+, *THzMap	FEEDBACK, HyGal, LMC+, GalMag, C+SQUAD
F-Q2: What regulates the structure and motions within molecular clouds?	[C II] 158 μ m, light hydrides, Far-IR polarimetry at 0.1 pc	HAWC+, GREAT, *THz-Map	SIMPLIFI, GalCen, HyGal
F-Q3: How does gas flow from parsec scales down to proto-stars and their disks?	Far-IR polarimetry at 0.1 pc, Mid/Far-IR variability & high-res spectroscopy	HAWC+, EXES, GREAT, FORCAST, FIFI-LS, *DirectDet	FIELDMAPS, SIMPLIFI, HyGal
D-Q2: How do gas, metals, and dust flow into, through, and out of galaxies?	[C II] 158 μ m, light hydrides, [O III] 88 μ m, Far-IR polarimetry <200 pc	GREAT, FIFI-LS, HAWC+, *THzMap, *DirectDet	HyGal, GalMag, LMC+
D-Q4: How do the histories of galaxies and their dark matter halos shape their observable properties?	[C II] & [O III] in galaxies (< 200pc), [¹³ C II]	GREAT, FIFI-LS, *THzMap	M51, LMC+, Galaxies
ARE WE ALONE? WORLDS AND SUNS IN CONTEXT			
E-Q3: How do habitable environments arise and evolve within the context of their planetary systems?	6 μ m H ₂ O, [O I] 63 μ m, PH ₃ , D/H ratio from HD0	FORCAST, EXES, GREAT	Lunar, Europa, Earth, Venus, Comets
F-DA: Detecting and characterizing forming planets	D/H ratio from HD	FORCAST, EXES, *DirectDet	Jupiter
E-Q2: What are the properties of individual planets, and which processes lead to planetary diversity?	R~10 ⁵ spectroscopy of H ₂ and organics, seasonal variation, occultations, high-speed (<0.1s) photometry, atmospheric haze evolution	FORCAST, EXES *DirectDet, FPI+,	Titan, Jupiter, Pluto, Triton
G-Q2: How does multiplicity affect the way a star lives and dies?	Mid/Far-IR photometric variations <i>Time Domain</i>	FORCAST, HAWC+	Stellar Mergers
G-Q3: What would stars look like if we could view them like we do the sun?	Mid/Far-IR photometry & spectroscopy, multi-epoch data <i>Time Domain</i>	FORCAST, FIFI-LS, GREAT, *DirectDet	Evolved Stars
E-Q1: What is the range of planetary system architectures and is the configuration of the solar system common?	Mid-IR photometry variation <i>Time Domain</i>	FORCAST	Debris Disk
F-Q4: Is planet formation fast or slow?	HD 112 μ m velocity-resolved of proto-planetary disks for gas mass	*DirectDet	Proto-planetary Disks
HOW DOES THE UNIVERSE WORK? NEW MESSENGERS AND NEW PHYSICS			
B-DA: Transforming our view of the universe by combining new information from light, particles, and gravitational waves	Mid/Far-IR photometric variations <i>Time Domain</i>	FORCAST, EXES, HAWC+, FIFI-LS, GREAT	Supernovae
B-Q4: What seeds supermassive black holes and how do they grow?	Far-IR polarimetry, Mid-IR photometry, Far-IR R ~10 ⁶ spectroscopy	FORCAST, HAWC+, GREAT	Galactic Center
D-Q3: How do supermassive black holes form and how is their growth coupled to the evolution of their host galaxies?	Far-IR photometry	HAWC+	High-z Galaxies

† Table 2.1 of Astro2020 Report *THzMap and *DirectDet are potential future SOFIA instruments SOFIA Legacy Programs