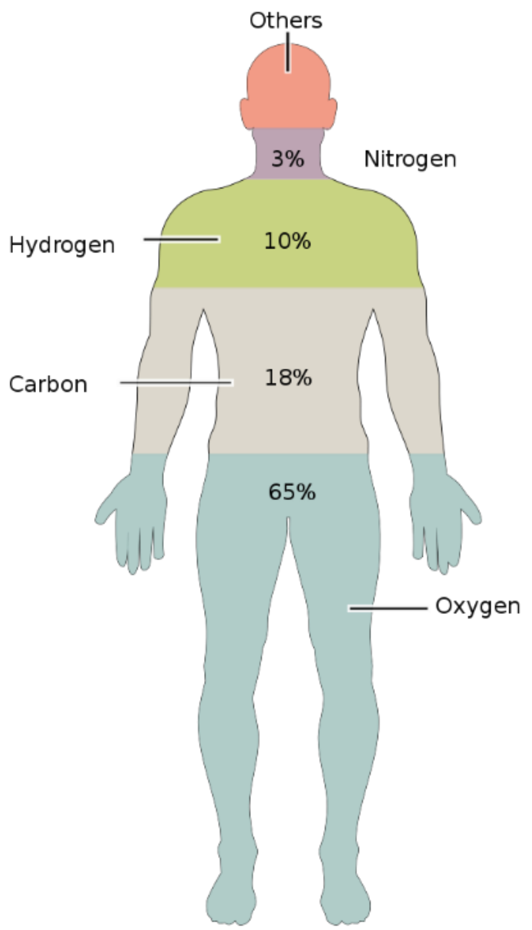
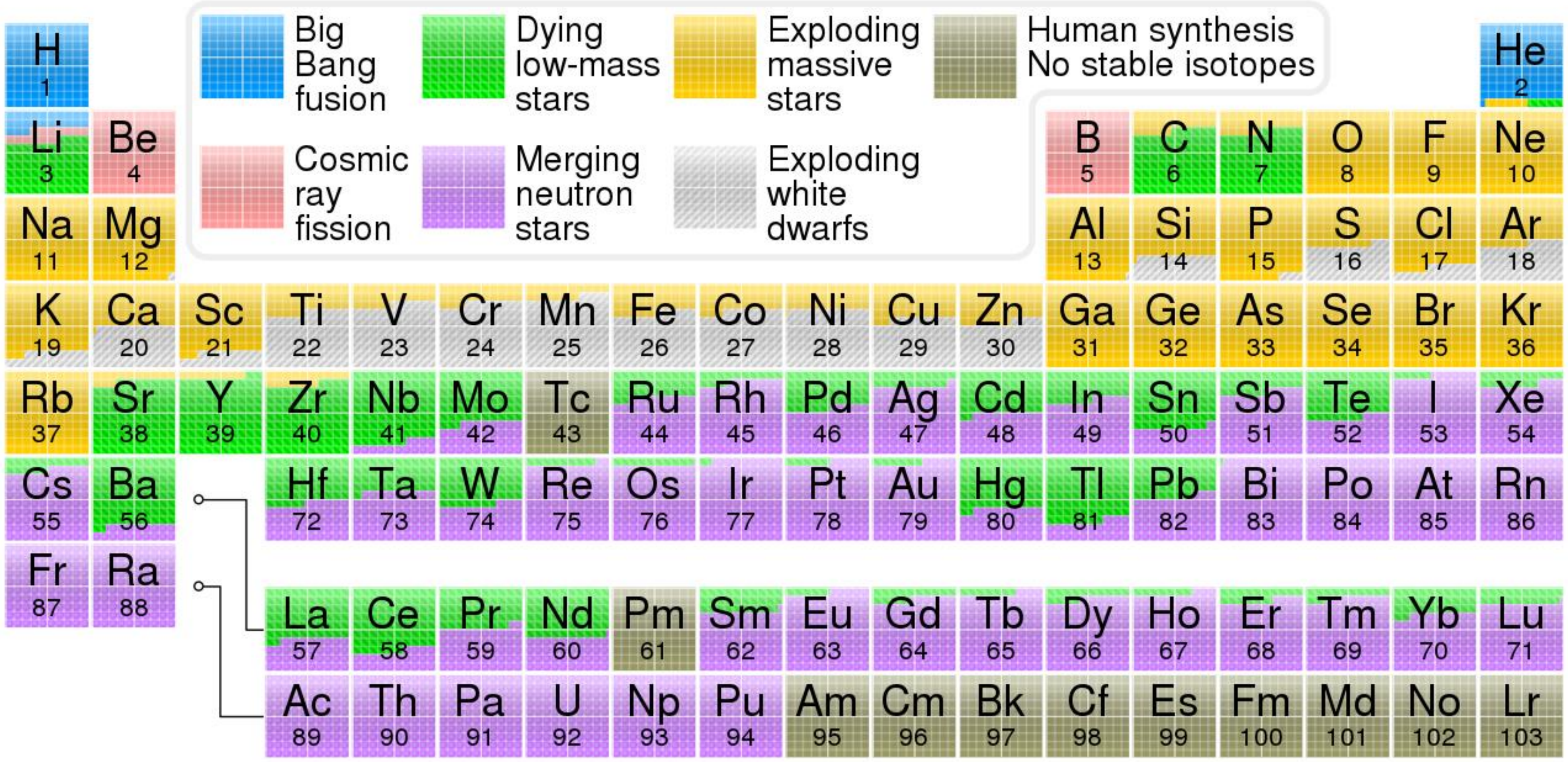
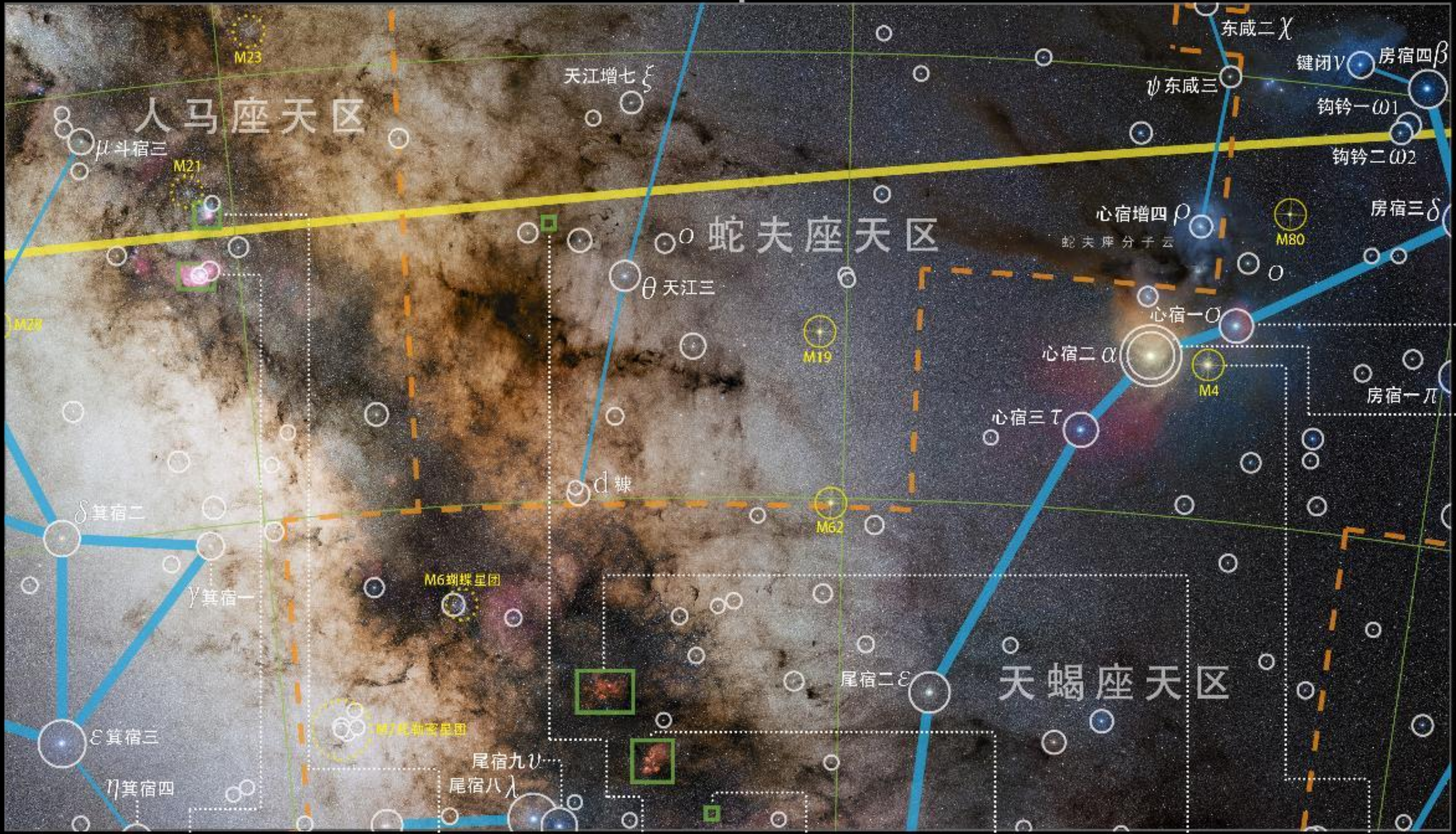
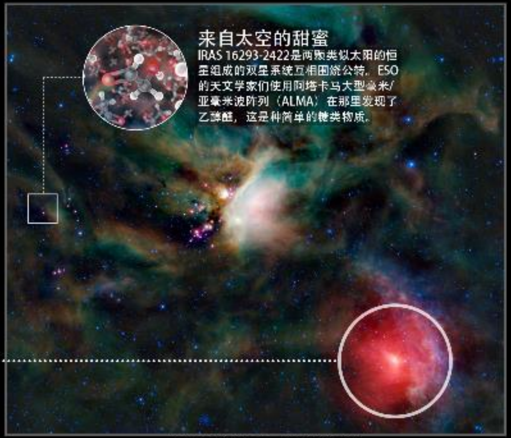
706生活实验室迈向星空系列活动
非正式演讲报告夜谈


Others
3%
Nitrogen
Hydrogen
10%
Carbon
18%
65%
Oxygen


Big Bang fusion
Dying low-mass stars
Exploding massive stars
Human synthesis No stable isotopes
Cosmic ray fission
Merging neutron stars
Exploding white dwarfs
H 1 He 2
Li 3 Be 4 B 5 C 6 N 7 O 8 F 9 Ne 10
Na 11 Mg 12 Al 13 Si 14 P 15 S 16 Cl 17 Ar 18
K 19 Ca 20 Sc 21 Ti 22 V 23 Cr 24 Mn 25 Fe 26 Co 27 Ni 28 Cu 29 Zn 30 Ga 31 Ge 32 As 33 Se 34 Br 35 Kr 36
Rb 37 Sr 38 Y 39 Zr 40 Nb 41 Mo 42 Tc 43 Ru 44 Rh 45 Pd 46 Ag 47 Cd 48 In 49 Sn 50 Sb 51 Te 52 I 53 Xe 54
Cs 55 Ba 56 Hf 72 Ta 73 W 74 Re 75 Os 76 Ir 77 Pt 78 Au 79 Hg 80 Tl 81 Pb 82 Bi 83 Po 84 At 85 Rn 86
Fr 87 Ra 88
La 57 Ce 58 Pr 59 Nd 60 Pm 61 Sm 62 Eu 63 Gd 64 Tb 65 Dy 66 Ho 67 Er 68 Tm 69 Yb 70 Lu 71
Ac 89 Th 90 Pa 91 U 92 Np 93 Pu 94 Am 95 Cm 96 Bk 97 Cf 98 Es 99 Fm 100 Md 101 No 102 Lr 103





蛇夫座分子云红外图像

蛇夫座分子云又名蛇夫座Rhi星云复合体，是距离地球460光年由气体和尘埃构成的恒星形成区。科学家已在这里发现了很多有趣的事物，例如糖类化学物质和未来可能诞生行星的原行星尘埃气体盘。红外能有效穿透尘埃和气体的遮挡，洞悉雾霭背后的秘密，还有很多天体在可见光下不起眼，在红外波段下则很明亮，也就是为什么新的韦伯太空望远镜以红外观测为主。
而这张照片是WISE(Wide-field Infrared Survey Explorer)红外太空望远镜拍摄的，它是NASA于2009年12月发射的，口径0.4米，主要用来巡天测绘，至今仍在工作。

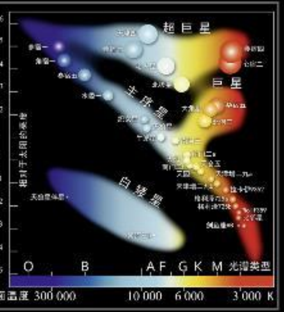
心宿二的光学干涉仪重建图像

心宿二的天文艺术画

心宿二（Antares）是最亮的恒星之一，位于天蝎座中心位置，距离地球约550光年。质量是太阳的12倍，也是已知最大的恒星之一。如果把心宿二取代太阳，那至少能把火星吞没，其亮度更是太阳的上万倍。心宿二发光亮度还会毫无规律的变化，是一颗变星。此外心宿二有颗相对暗的蓝色伴星，质量为太阳的7.2倍，但因心宿二本身太亮而难以观测这颗伴星。

赫茨-罗素图

简称赫罗图，统计了恒星的亮度和颜色的关系。注意心宿二在图上的位置，这是一颗红超巨星，已告别主序星阶段，在未来耗尽核心的氦之后会发生超新星爆发。
O和B型光谱主序星又称蓝巨星，非常明亮且质量大但寿命仅几百万年，会成蓝超巨星或者沃尔夫-拉叶星，然后超新星爆发，最终成黑洞或中子星。
M型主序星又叫红矮星,虽然质量小发光暗，但特长寿，能稳定燃烧上万亿年，不会膨胀或者爆发，只会缓慢变暗，著名的TRAPPIST-1 就是红矮星。
太阳则是一颗G级主序星，G型主序星又称黄矮星，寿命约100亿年,然后膨胀成红巨星最终演化成白矮星和围绕它的行星状星云，也不会爆发。
恒星的质量下限大约是80倍木星质量，低于这质量就无法点燃氢的聚变。

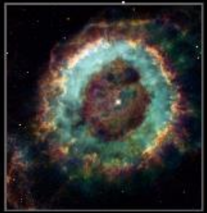


M8礁湖星云

礁湖星云（Lagoon Nebula）是射手座里巨大的发射星云，距离地球约4100光年，星云大约横跨100光年。因为星云里的氢被恒星的紫外线辐射电离而发光，发光颜色和辐射能量强弱有关。这是活跃的恒星形成区，图中黑暗区域为气体和尘埃，是形成新恒星与行星的原料。

M20三裂星云

三裂星云（Trifid Nebula）距离5200光年，也是恒星诞生区。混合了发射星云、反射星云（蓝）以及暗星云。



NGC6369小鬼星云

小鬼星云（Little Ghost Nebula）距离地球2000-5000光年，是行星状星云。是类似太阳的恒星死亡后抛出的物质形成的，中心留有一颗白矮星。

NGC6302蝴蝶星云

NGC6302也是一团行星状星云，距离约3800光年，"蝴蝶"的两翼是恒星两极抛出的气体形成的，红色边缘是氮发出的光。

NGC6334猫掌星云

猫掌星云（Cat's Paw Nebula）距离地球约5500光年，是生机勃勃的恒星摇篮也混杂着超新星遗迹。这片发射星云，横跨约50光年。

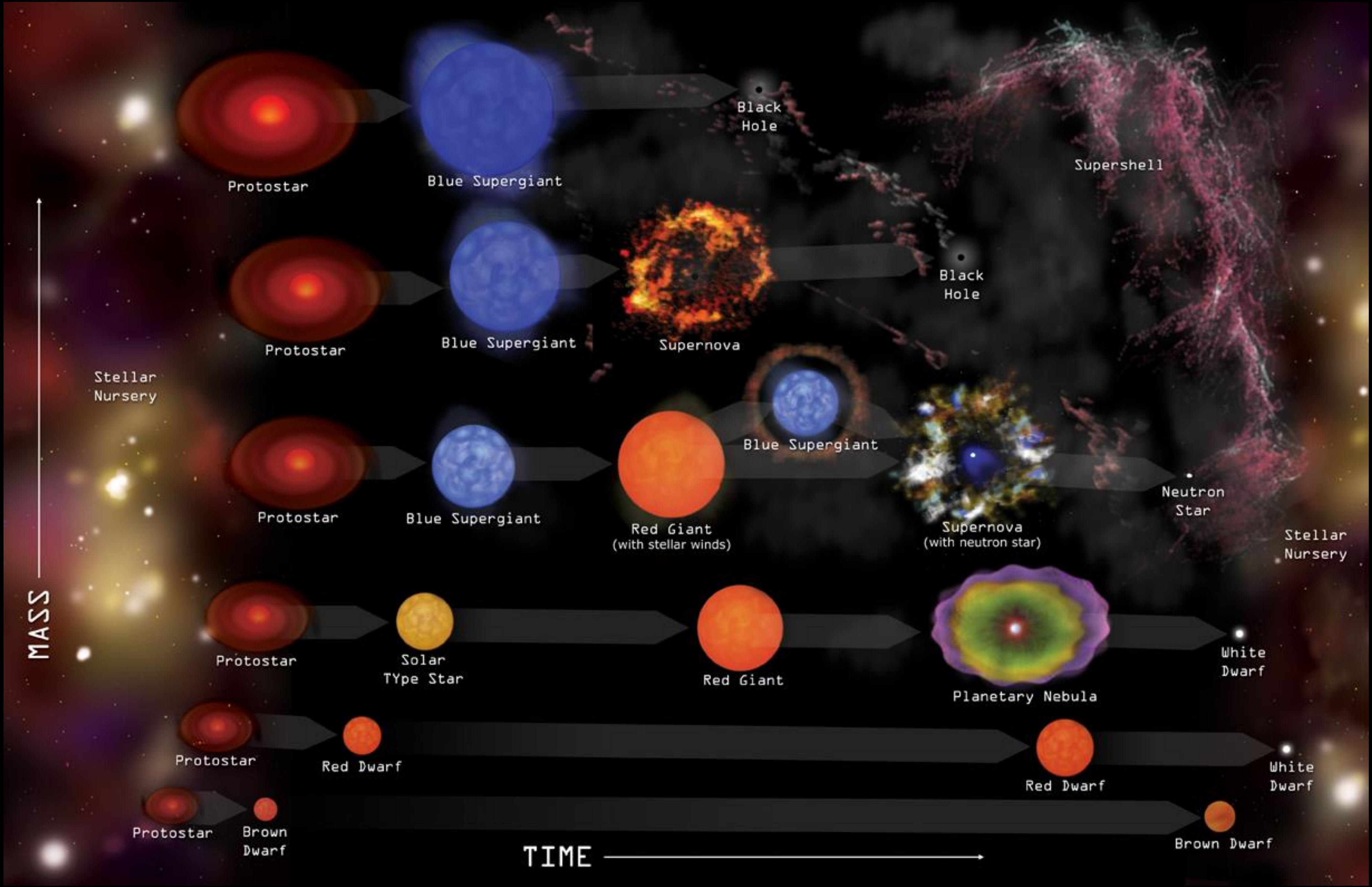
NGC6357龙虾星云

龙虾星云（Lobster Nebula）距离约8000光年，也是发射星云，这片星云孕育了不少非常明亮的年轻蓝巨星，就形成了一个引人注目的开放星团。

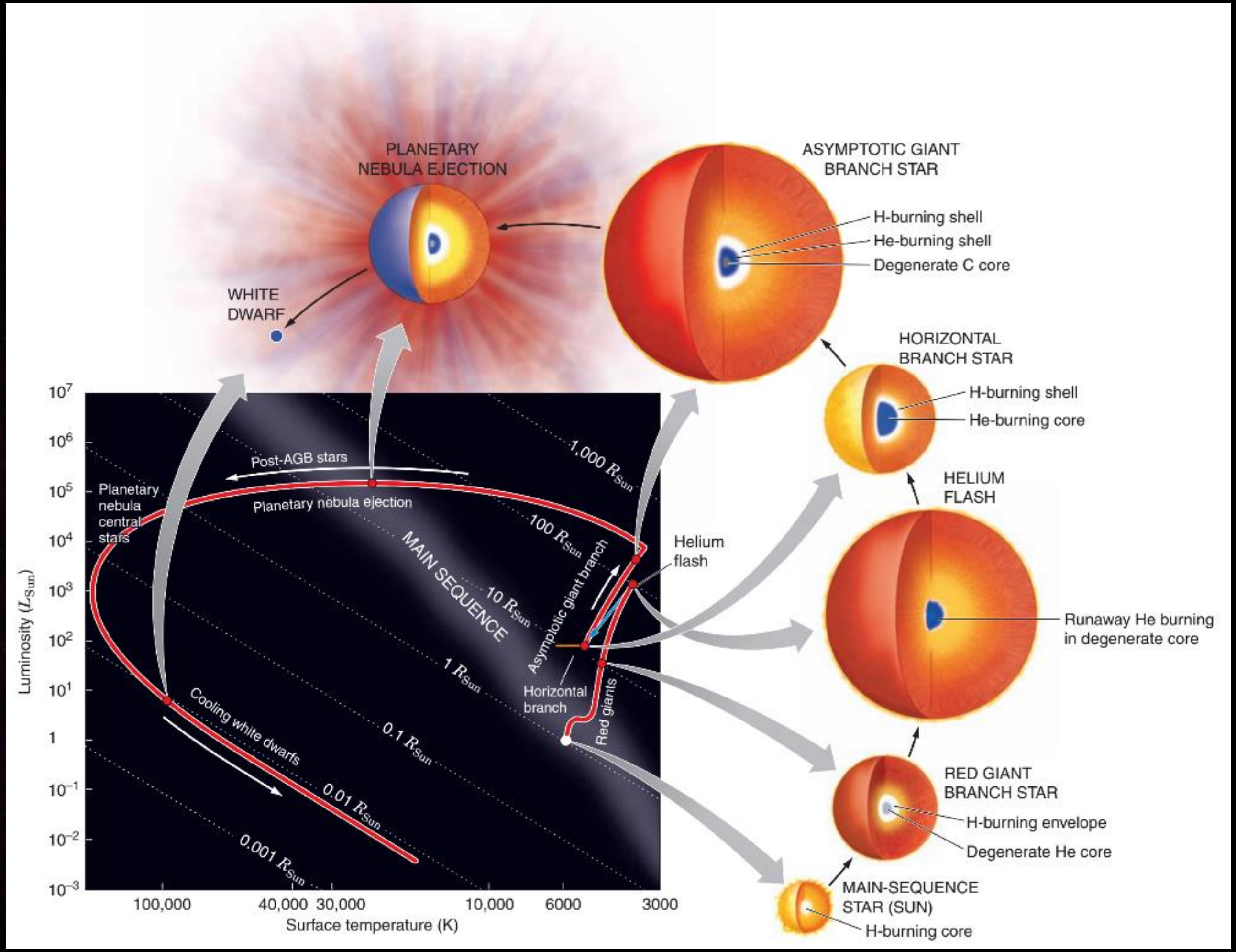
M4球状星团

M4星团距离约7200光年。这个球状星团包含了几万颗古老恒星，半径却只有35光年，使得恒星之间距离很近。

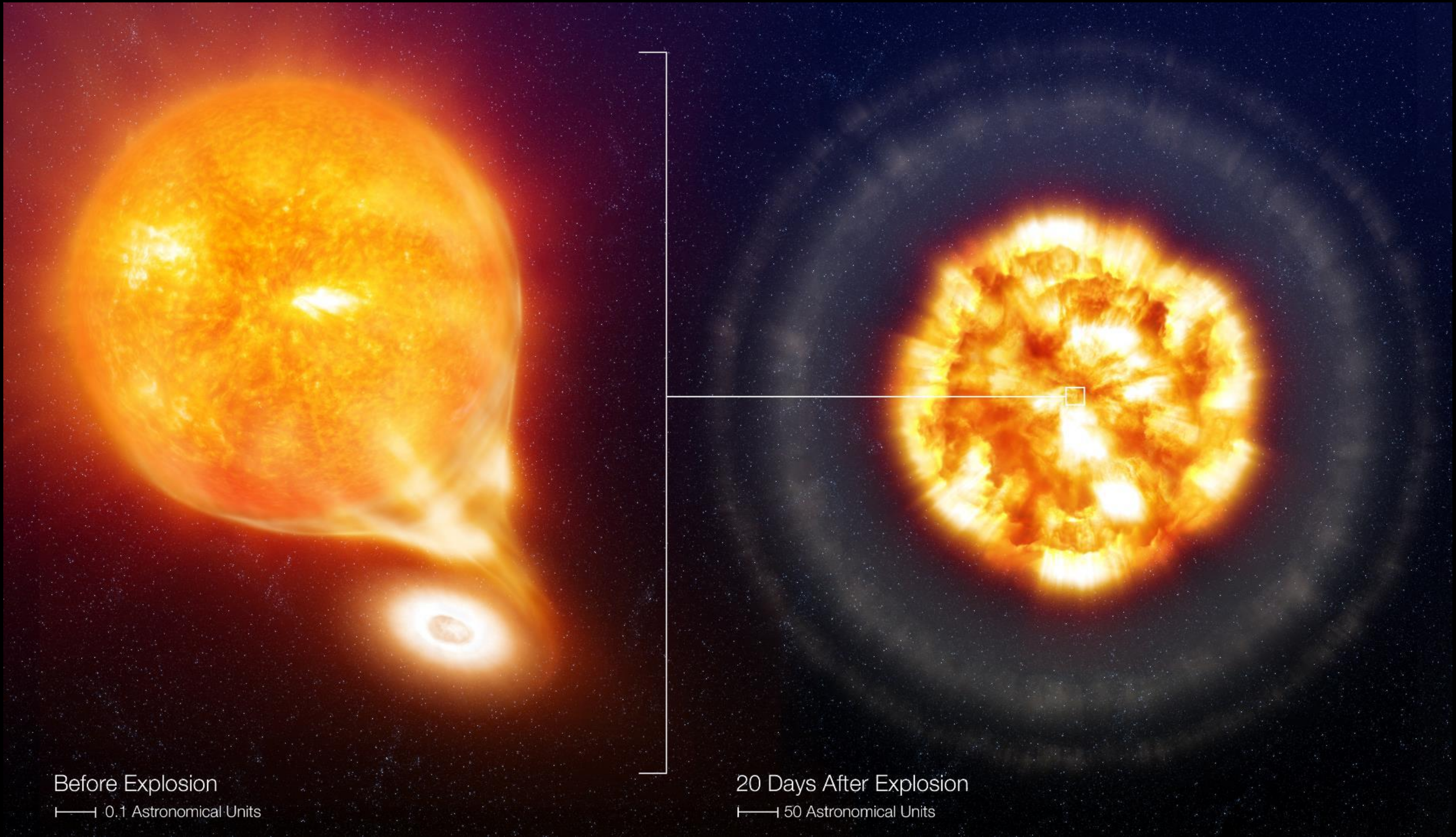
本图展现的是银河系中心，素材和信息来源于欧洲南方天文台（ESO）、美国国家航空航天局（NASA）、欧洲航空航天局（ESA）、国际天文联合学会（IAU），星座以IAU官方为标准。注意：人马座又译为射手座，不要和半人马座搞混。感谢法国斯特拉斯堡天文台的Aladin软件和开源的Stellarium天文模拟软件。 设计制图：NCC21382

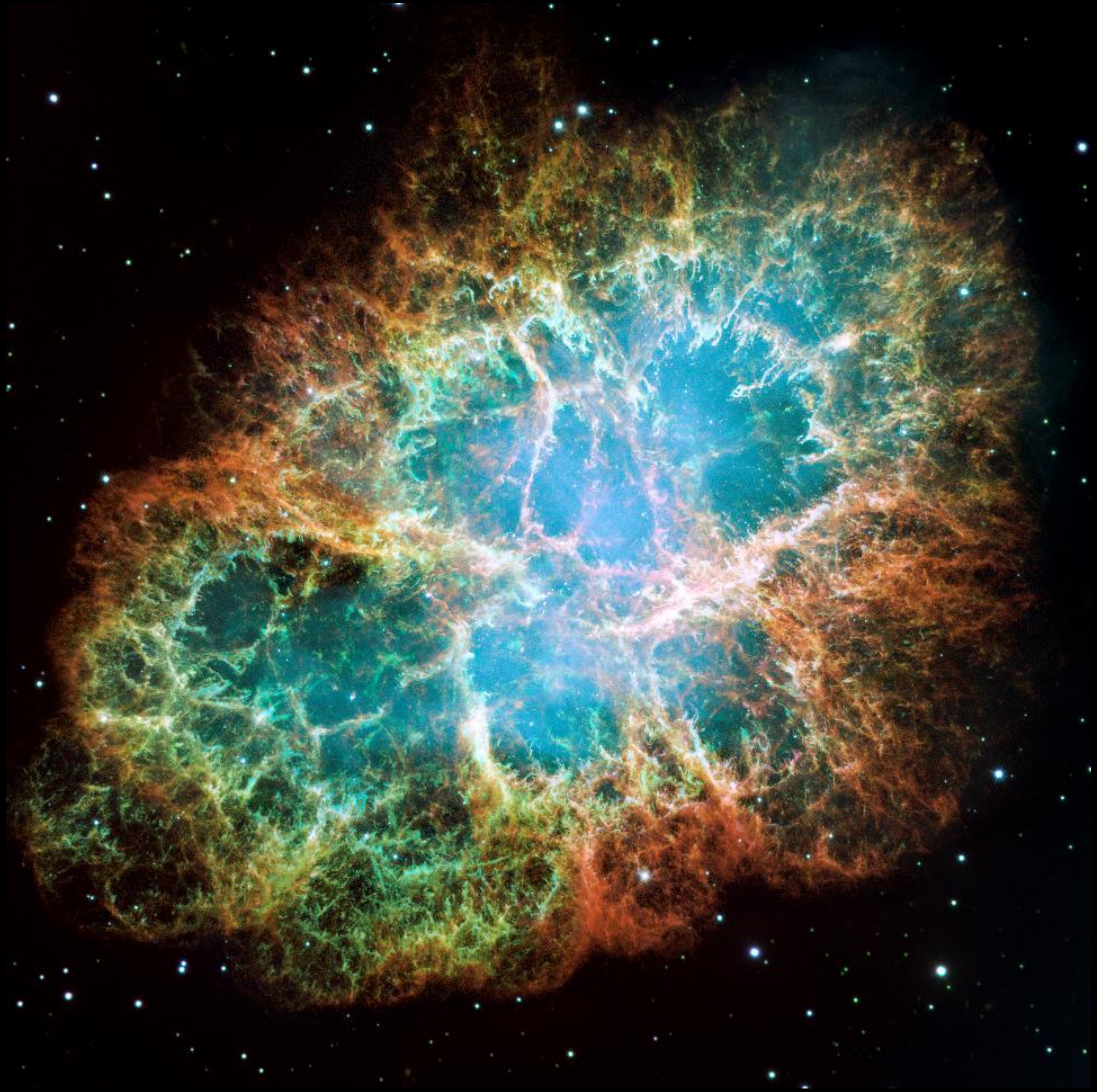


Protostar
Blue Supergiant
Black Hole
Supershell
Protostar
Blue Supergiant
Supernova
Black Hole
Stellar Nursery
Protostar
Blue Supergiant
Red Giant
(with stellar winds)
Blue Supergiant
Supernova
(with neutron star)
Neutron Star
Stellar Nursery
Protostar
Solar TYpe Star
Red Giant
Planetary Nebula
White Dwarf
Protostar
Red Dwarf
Red Dwarf
White Dwarf
Protostar
Brown Dwarf
Brown Dwarf
MASS
TIME



PLANETARY
NEBULA EJECTION
ASYMPTOTIC GIANT
BRANCH STAR
H-burning shell
He-burning shell
Degenerate C core
WHITE
DWARF
HORIZONTAL
BRANCH STAR
H-burning shell
He-burning core
HELIUM
FLASH
Runaway He burning
in degenerate core
RED GIANT
BRANCH STAR
H-burning envelope
Degenerate He core
MAIN-SEQUENCE
STAR (SUN)
H-burning core
Post-AGB stars
Planetary nebula ejection
Planetary
nebula
central
stars
MAIN SEQUENCE
Asymptotic giant branch
Helium
flash
Horizontal
branch
Red giants
Cooling white dwarfs
1,000 R_{Sun}
100 R_{Sun}
10 R_{Sun}
1 R_{Sun}
0.1 R_{Sun}
0.01 R_{Sun}
0.001 R_{Sun}
Luminosity (L_{Sun})
10^7
10^6
10^5
10^4
10^3
10^2
10^1
1
10^{-1}
10^{-2}
10^{-3}
100,000
40,000 30,000
10,000
6000
3000
Surface temperature (K)


Before Explosion
0.1 Astronomical Units
20 Days After Explosion
50 Astronomical Units



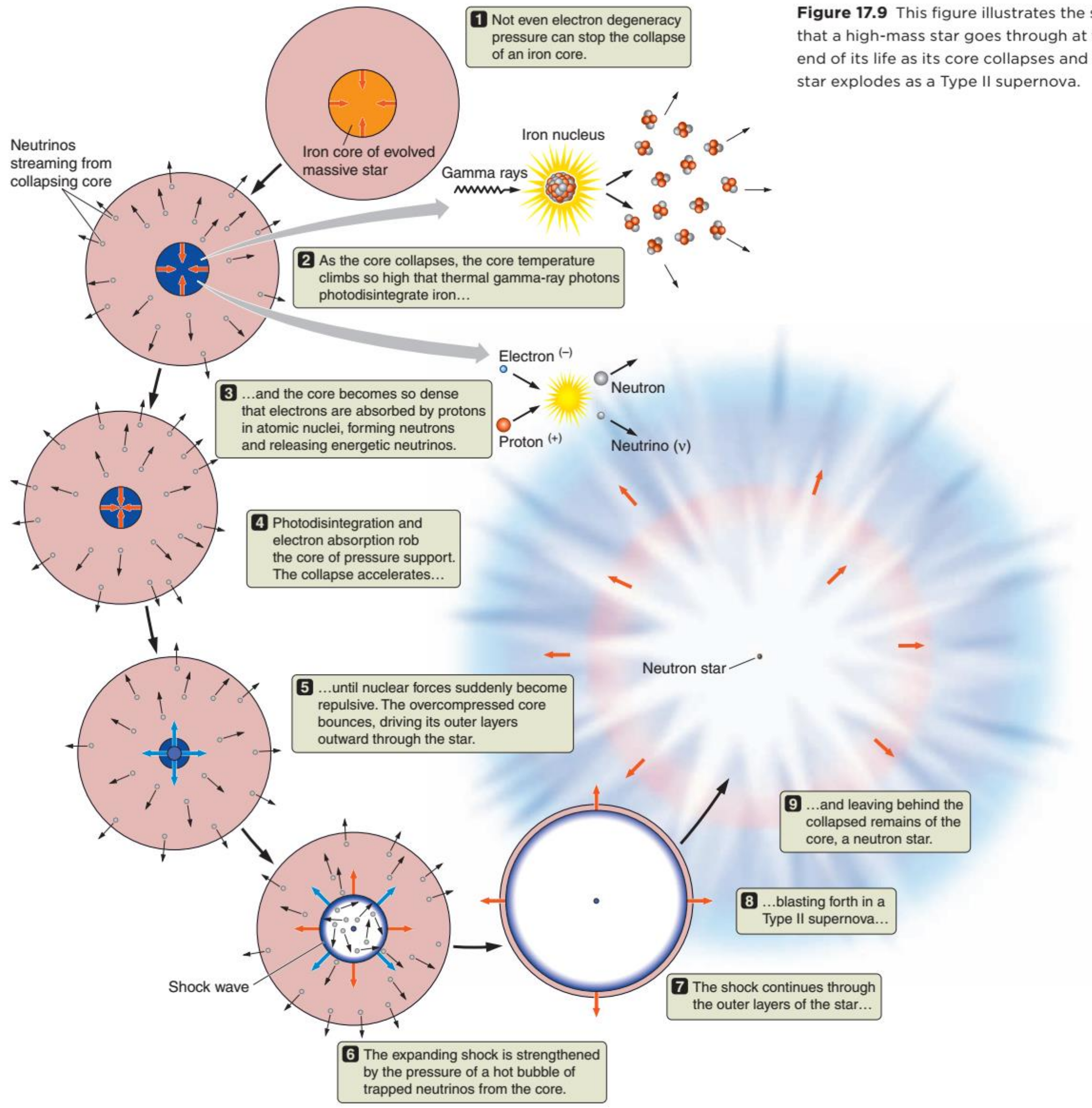
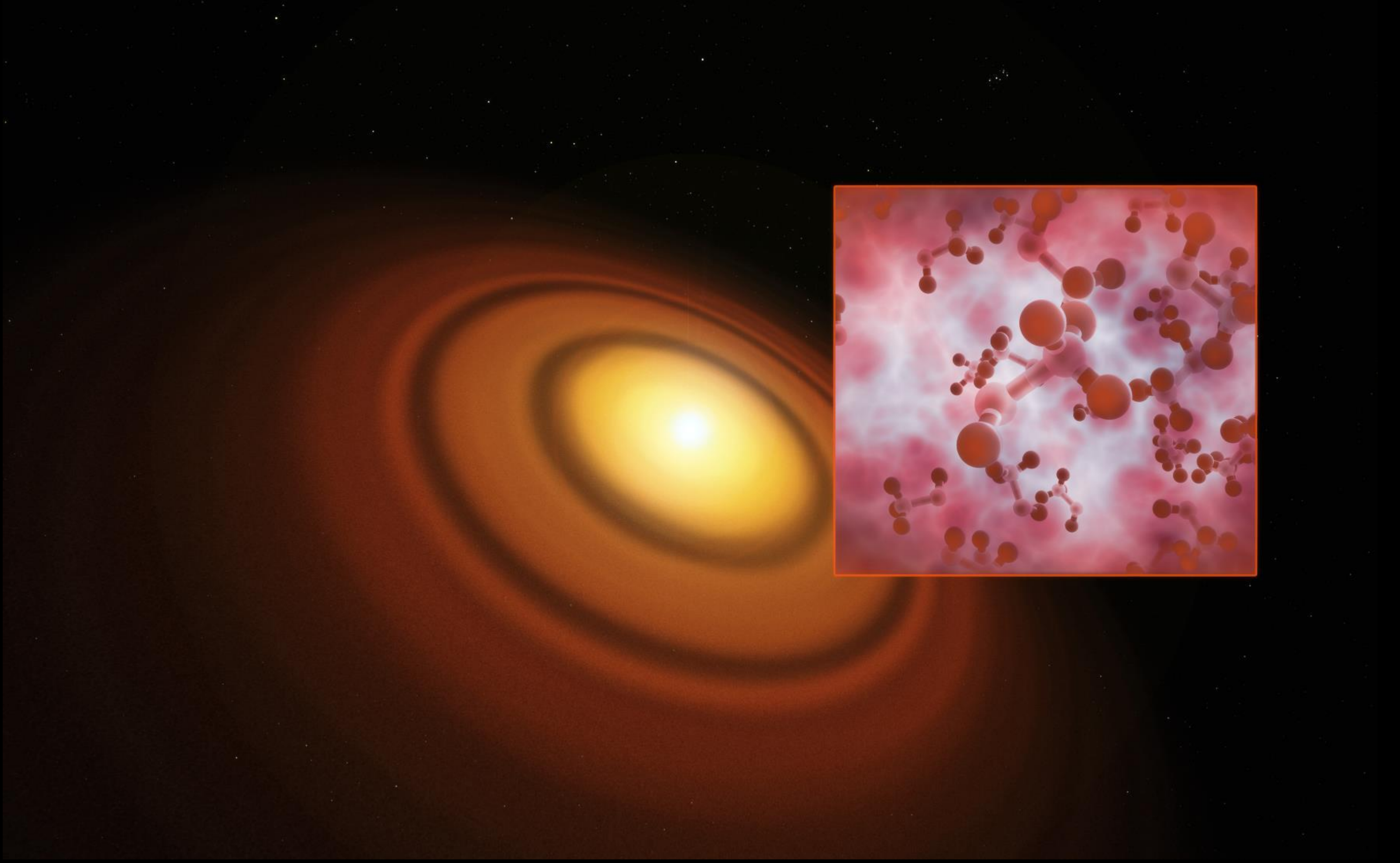


Figure 17.9 This figure illustrates the stages that a high-mass star goes through at the end of its life as its core collapses and the star explodes as a Type II supernova.



Cis-Lunar Space

A deep dpace harbor for expanded human presence

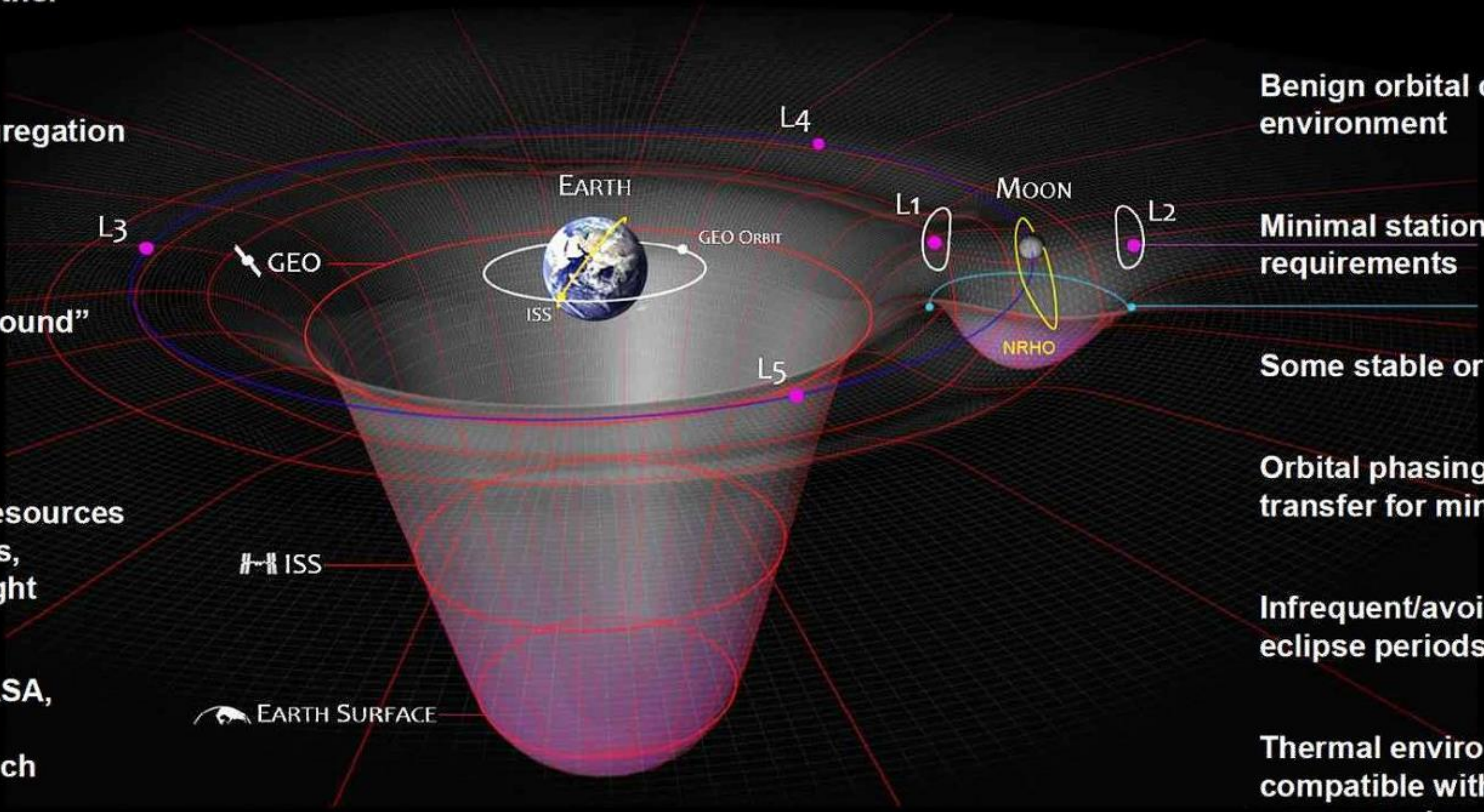
Only ~3 to 5 days away from Earth yet farther than Apollo went

Ideal mission aggregation location

The next "high ground" beyond GEO

Access to local resources including volatiles, gravity and sunlight

Accessible by NASA, commercial, and international launch systems



True deep space radiation environment

Benign orbital debris environment

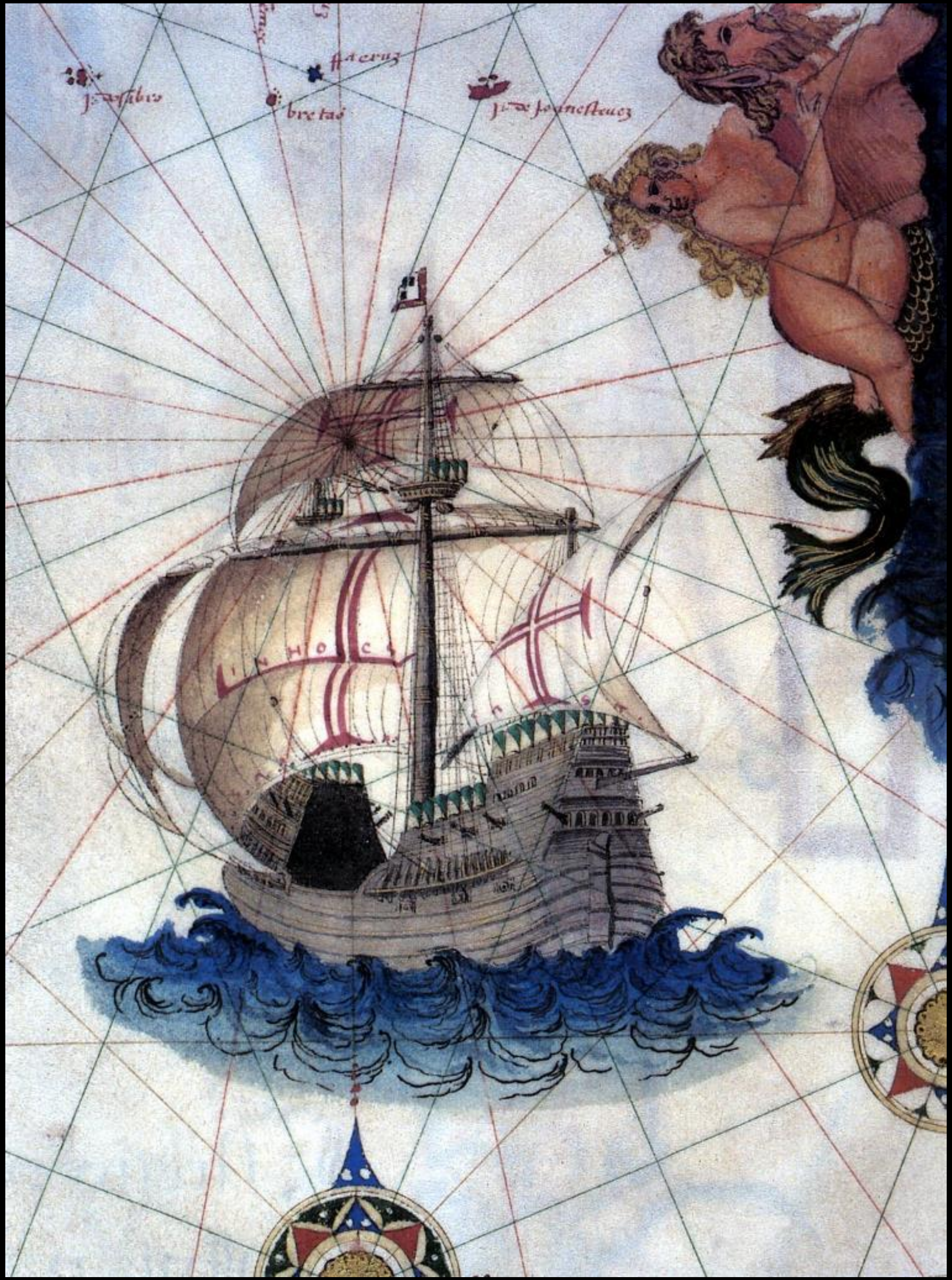
Minimal station keeping requirements

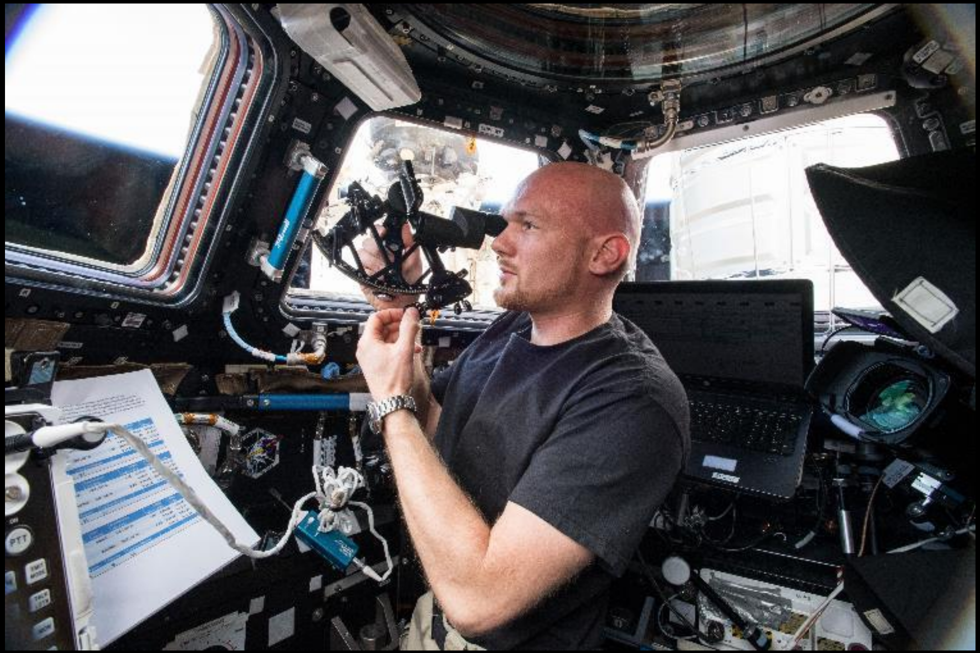
Some stable orbits

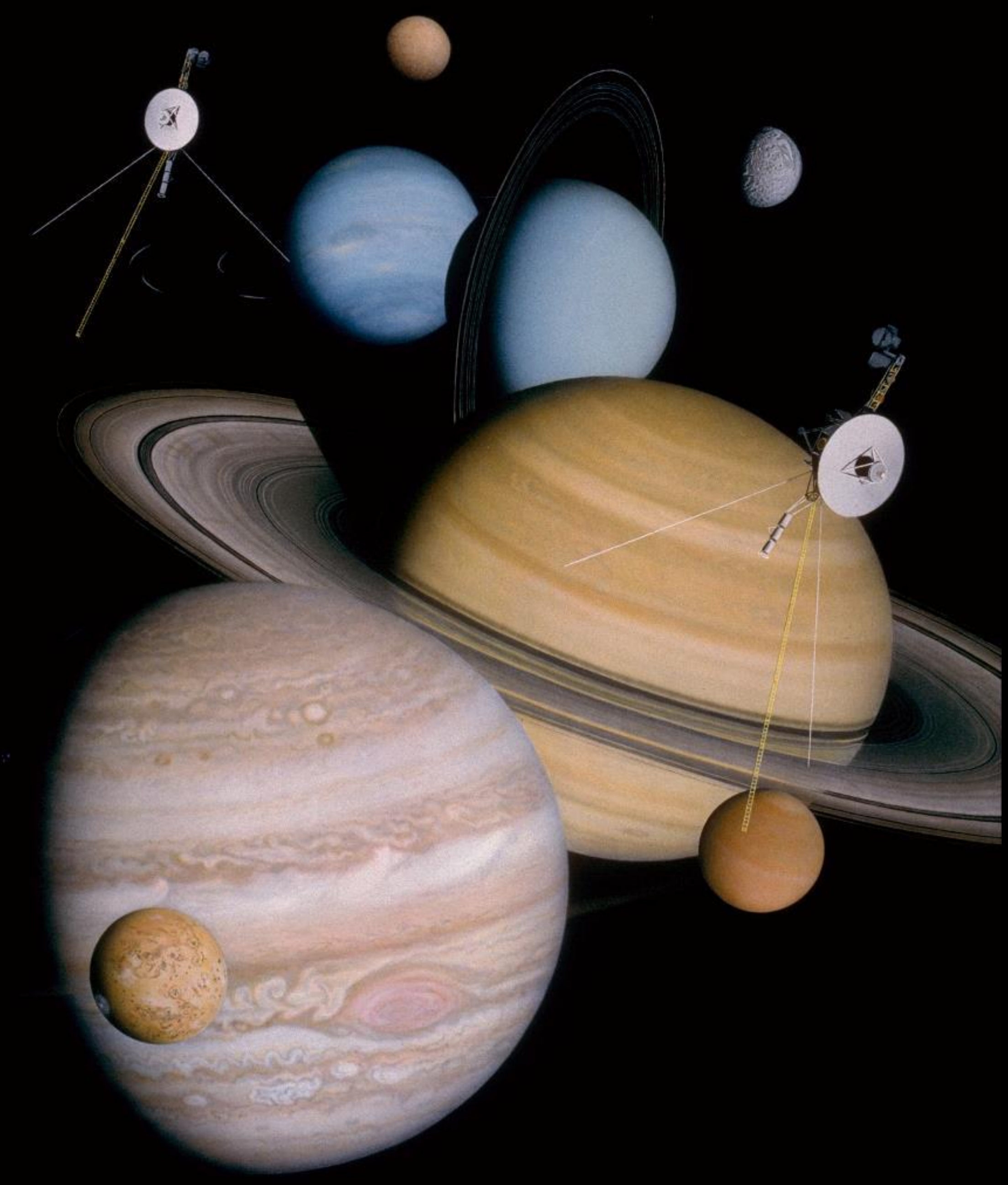
Orbital phasing and transfer for minimal energy

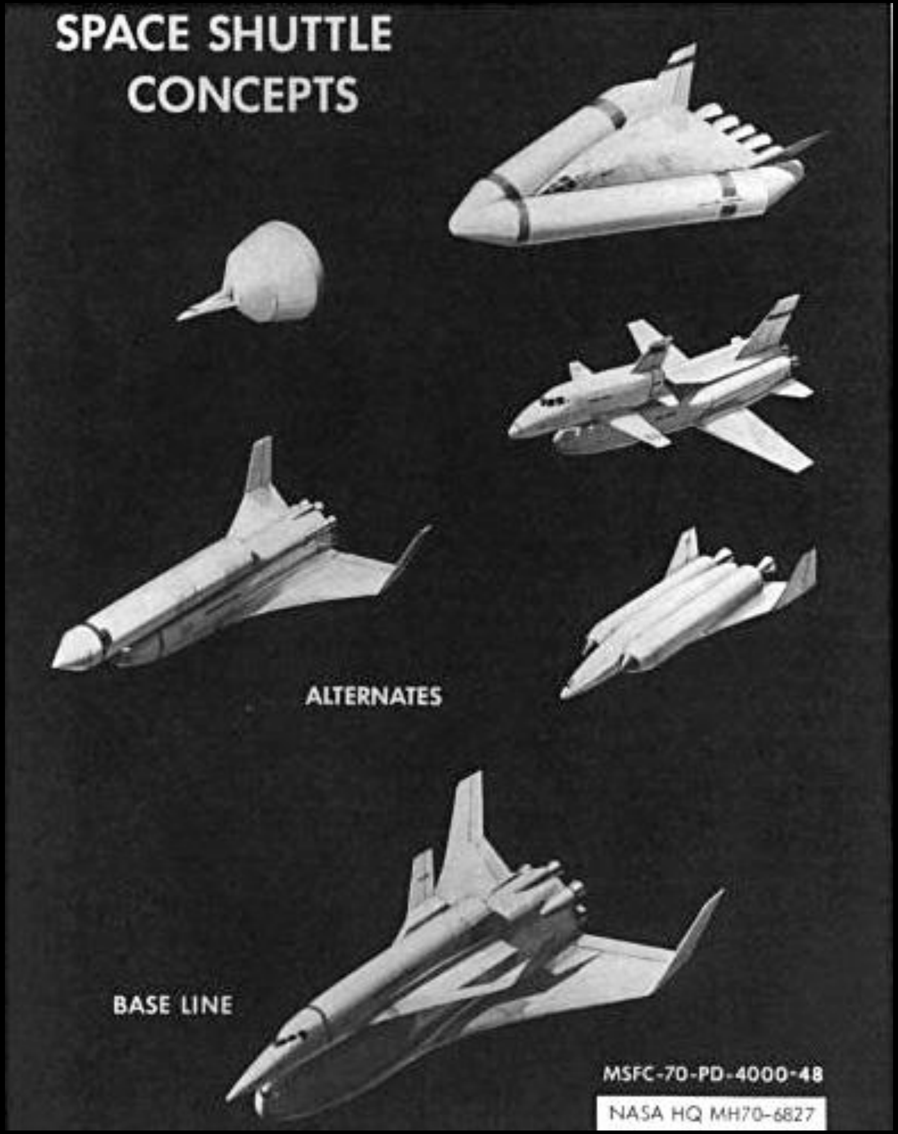
Infrequent/avoidable eclipse periods

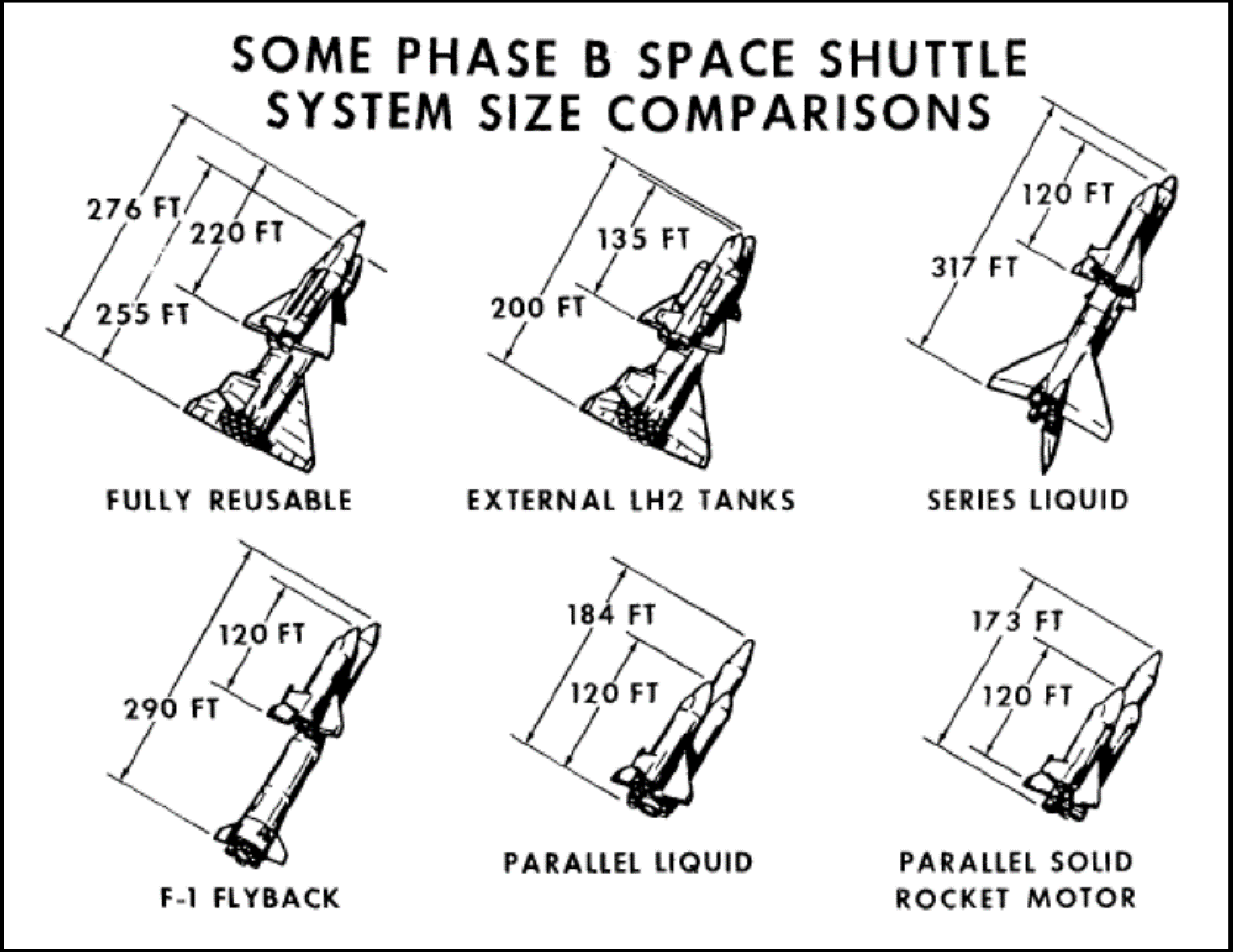
Thermal environment compatible with cryogenic oxygen and methane









SPACE SHUTTLE
CONCEPTS
ALTERNATES
BASE LINE
MSFC-70-PD-4000-48
NASA HQ MH70-6827


SOME PHASE B SPACE SHUTTLE
SYSTEM SIZE COMPARISONS
276 FT
220 FT
255 FT
FULLY REUSABLE
135 FT
200 FT
EXTERNAL LH2 TANKS
120 FT
317 FT
SERIES LIQUID
120 FT
290 FT
F-1 FLYBACK
184 FT
120 FT
PARALLEL LIQUID
173 FT
120 FT
PARALLEL SOLID
ROCKET MOTOR


Enterprise
United States

ACTIVE LAUNCH VEHICLES
Vanguard
11 launches
Redstone
64 launches
Navaho
11 launches
Jupiter
75 launches
Thor
380 launches
Atlas I/II/III
579 launches
Saturn I/IB
19 launches
Saturn V
13 launches
Titan I - IV
369 launches
Peacekeeper
51 launches
Athena
7 launches
Space Shuttle
135 launches
Antares
4 launches
Delta I/II/III
344 launches
Atlas V
More than 79 launches
Delta IV
More than 35 launches

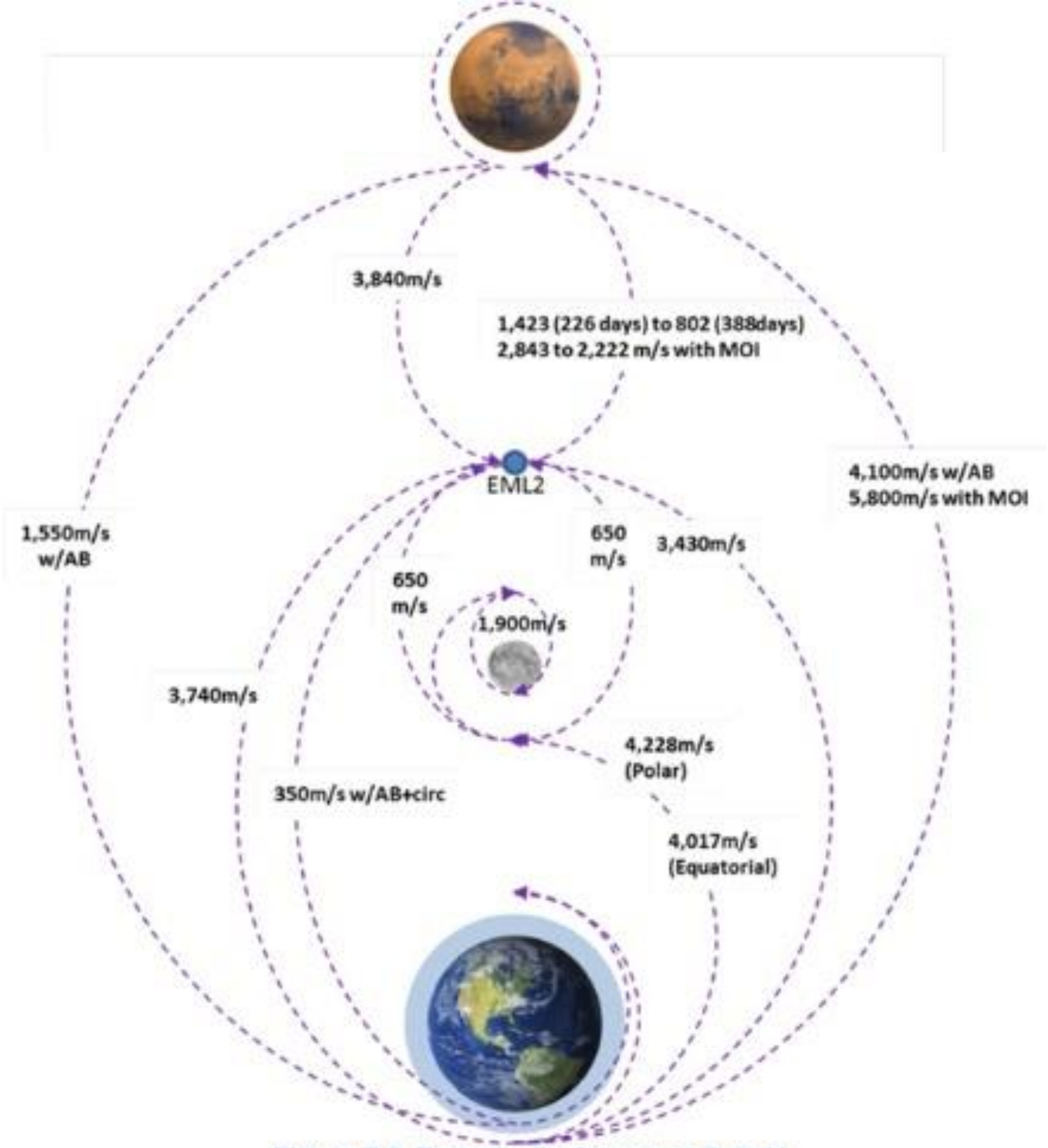
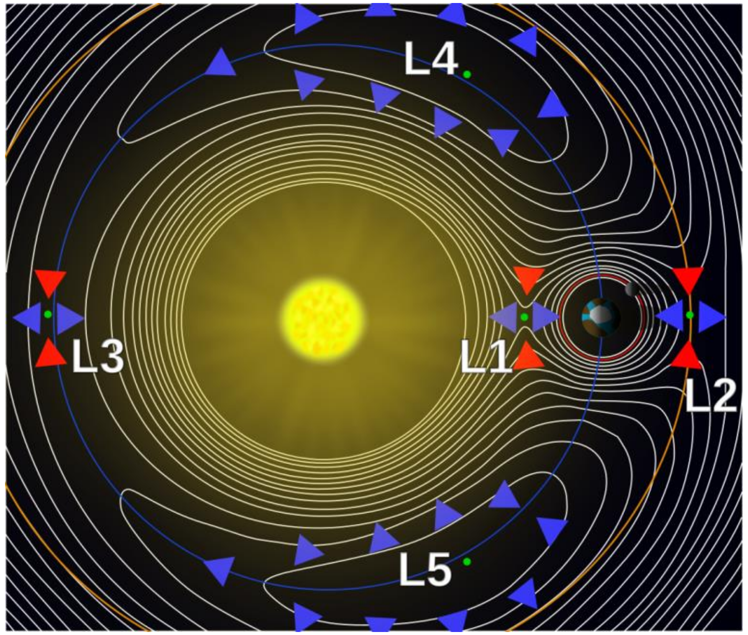
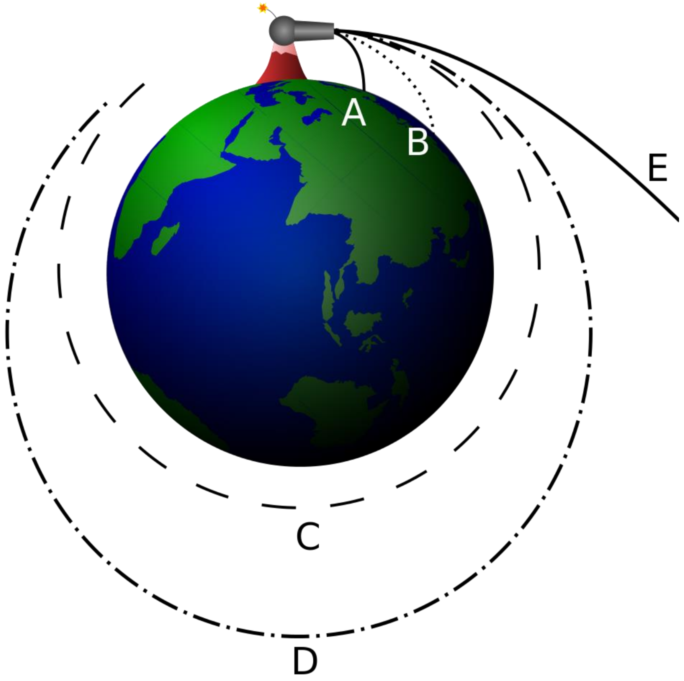
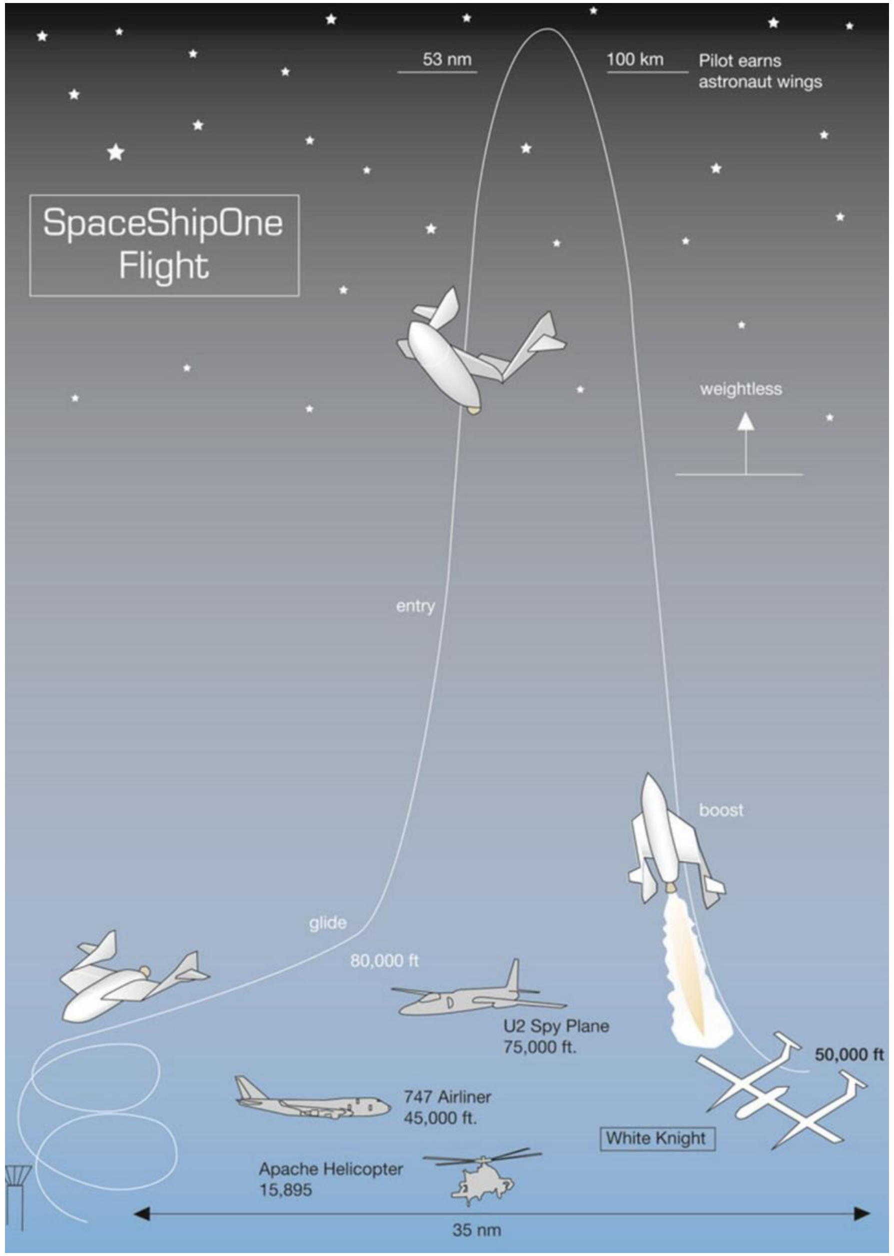
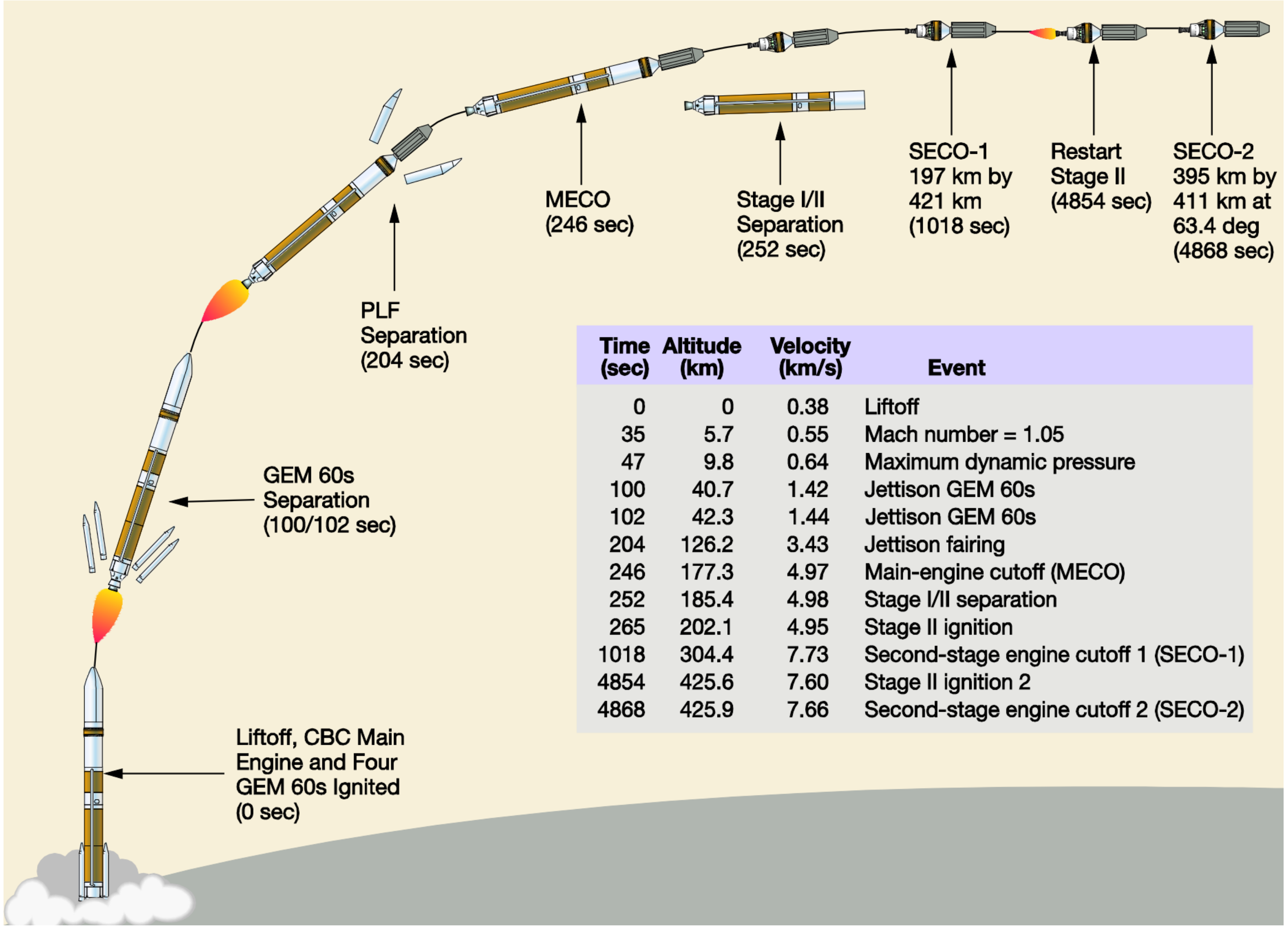


Figure T-2. Transfer Performance DeltaV

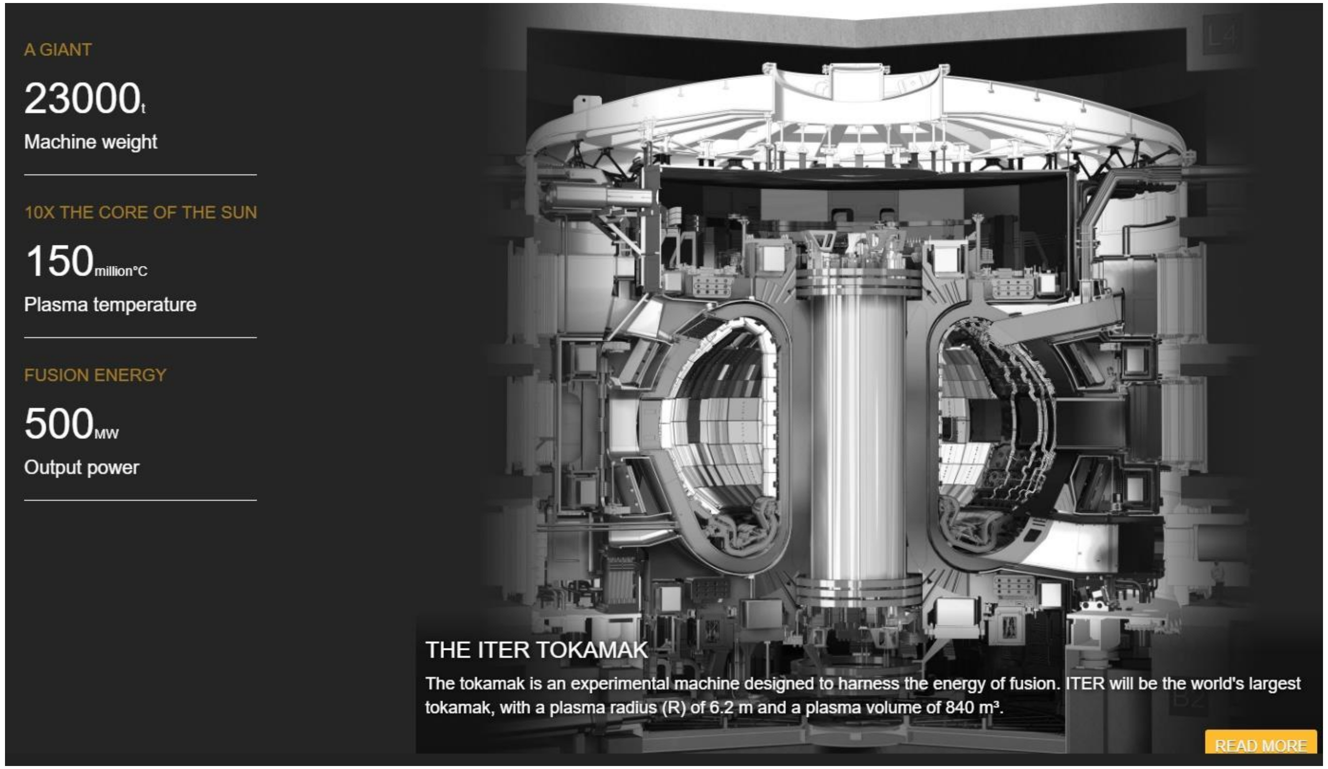


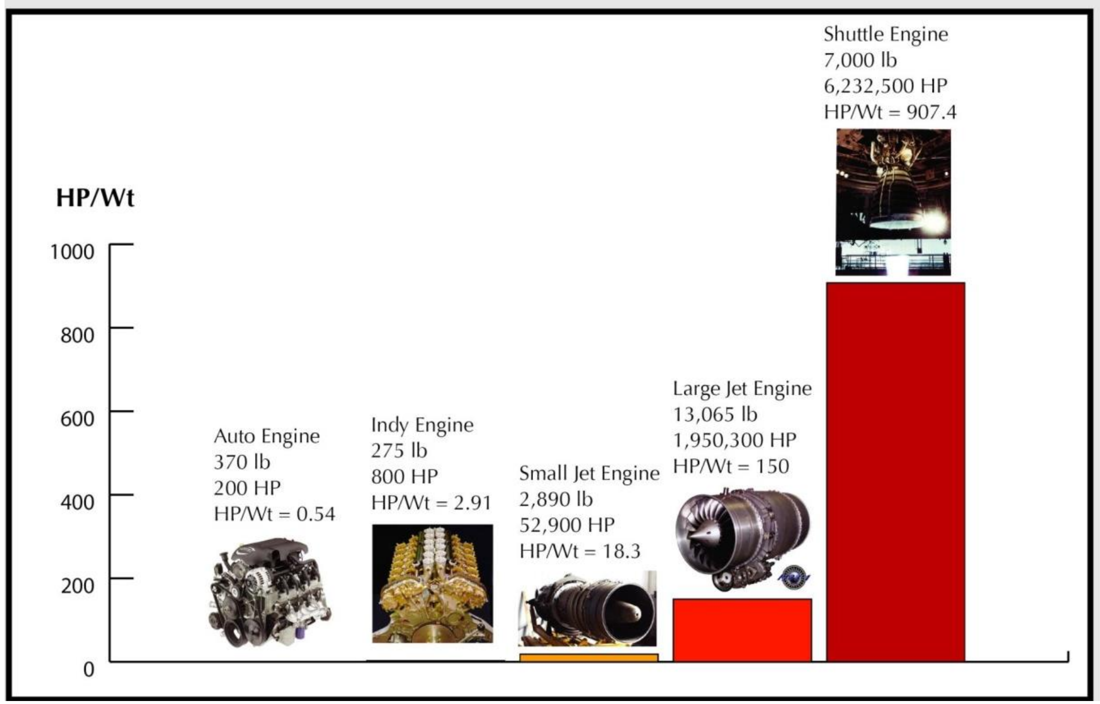


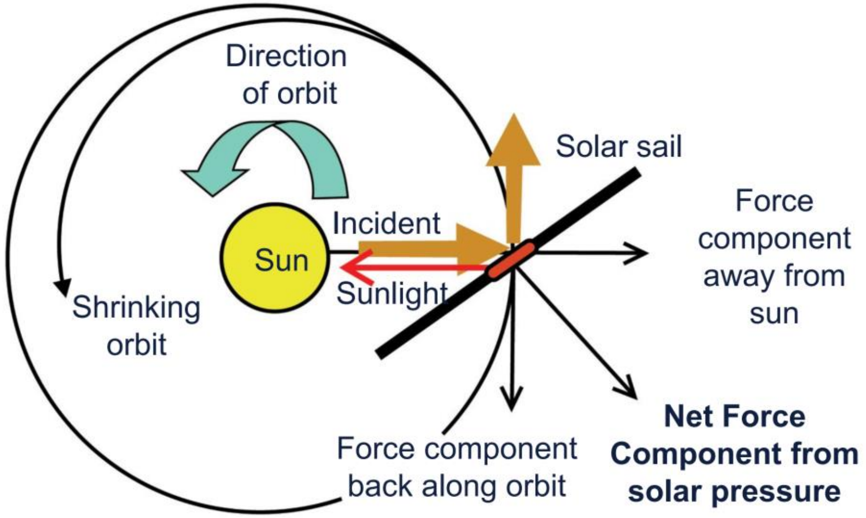


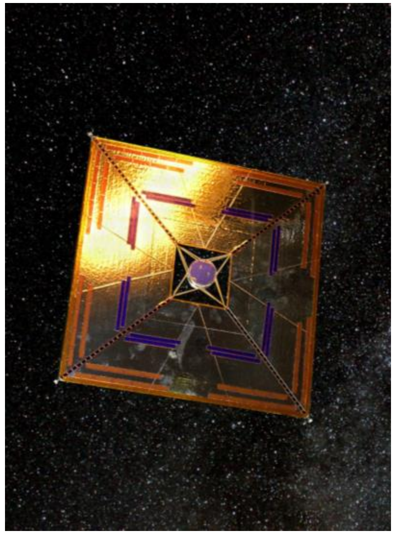


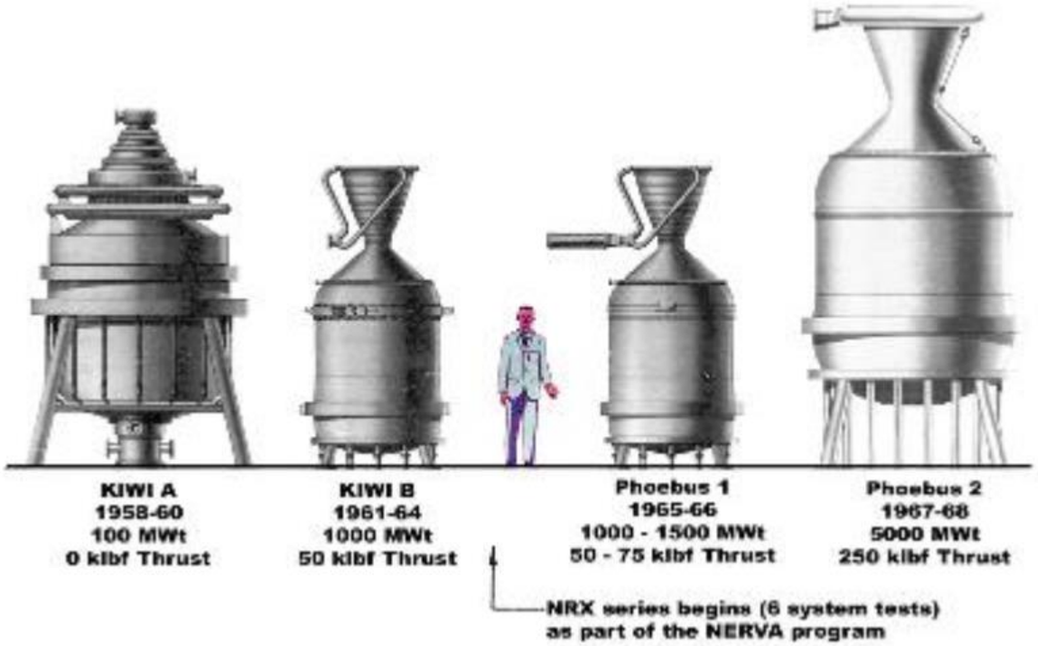
Time (sec)	Altitude (km)	Velocity (km/s)	Event
0	0	0.38	Liftoff
35	5.7	0.55	Mach number = 1.05
47	9.8	0.64	Maximum dynamic pressure
100	40.7	1.42	Jettison GEM 60s
102	42.3	1.44	Jettison GEM 60s
204	126.2	3.43	Jettison fairing
246	177.3	4.97	Main-engine cutoff (MECO)
252	185.4	4.98	Stage I/II separation
265	202.1	4.95	Stage II ignition
1018	304.4	7.73	Second-stage engine cutoff 1 (SECO-1)
4854	425.6	7.60	Stage II ignition 2
4868	425.9	7.66	Second-stage engine cutoff 2 (SECO-2)


A GIANT
23000t
Machine weight
10X THE CORE OF THE SUN
150 million°C
Plasma temperature
FUSION ENERGY
500MW
Output power
THE ITER TOKAMAK
The tokamak is an experimental machine designed to harness the energy of fusion. ITER will be the world's largest tokamak, with a plasma radius (R) of 6.2 m and a plasma volume of 840 m³.
READ MORE

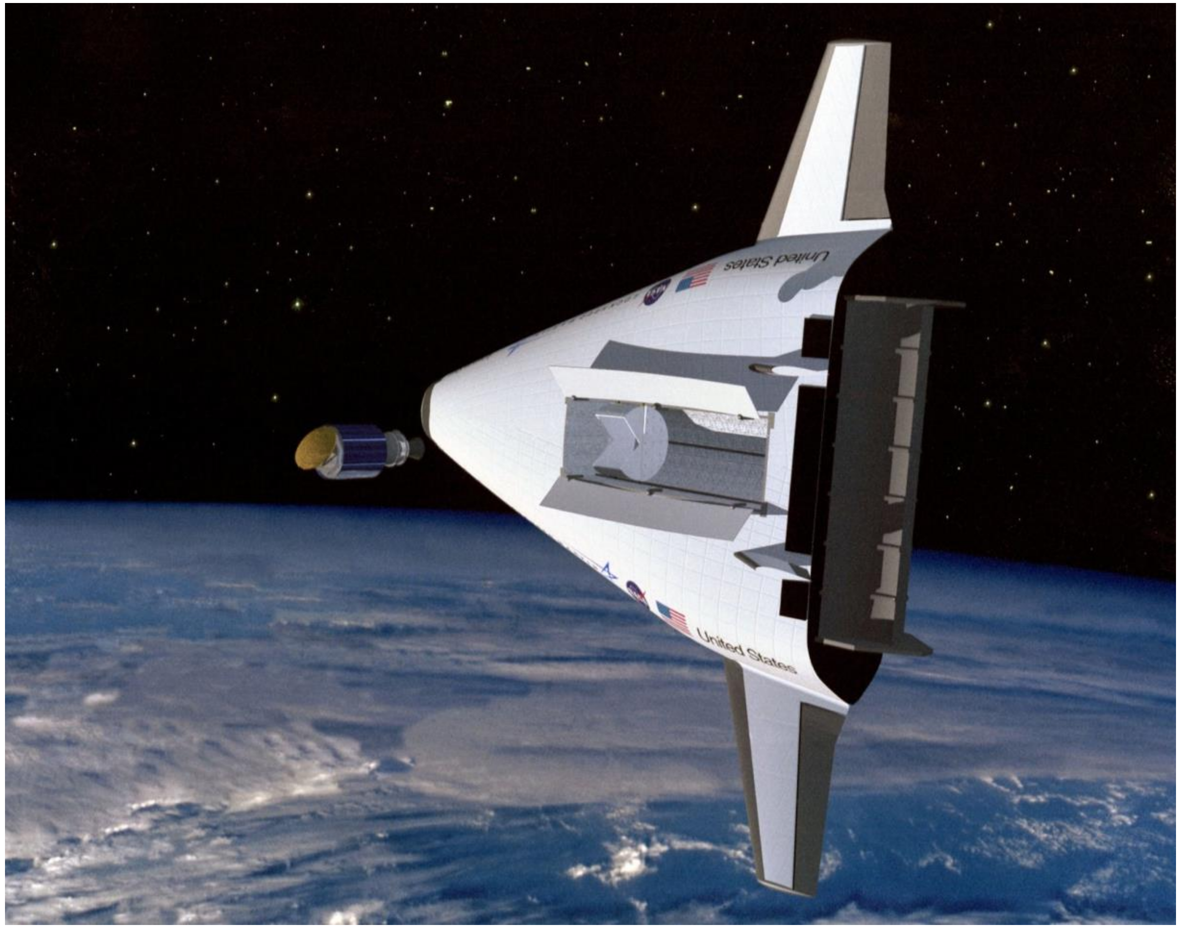

HP/Wt
1000
800
600
400
200
0
Auto Engine
370 lb
200 HP
HP/Wt = 0.54
Indy Engine
275 lb
800 HP
HP/Wt = 2.91
Small Jet Engine
2,890 lb
52,900 HP
HP/Wt = 18.3
Large Jet Engine
13,065 lb
1,950,300 HP
HP/Wt = 150
Shuttle Engine
7,000 lb
6,232,500 HP
HP/Wt = 907.4

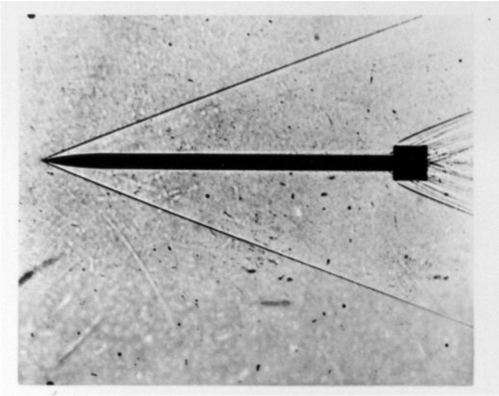

Direction of orbit
Solar sail
Incident
Sun
Sunlight
Shrinking orbit
Force component away from sun
Force component back along orbit
Net Force Component from solar pressure

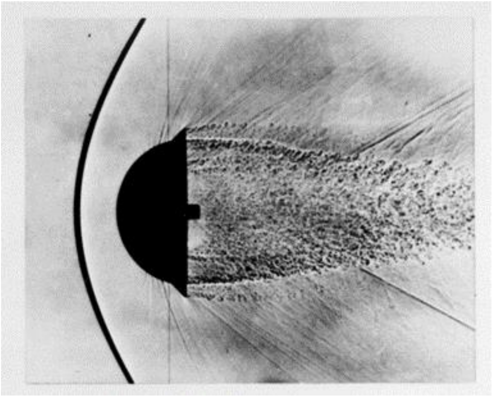


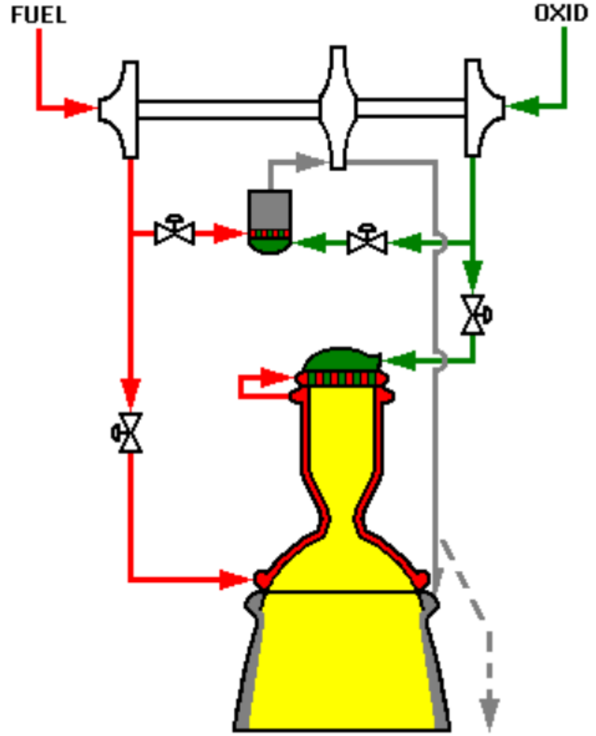

KIWI A
1958-60
100 MWt
0 klbf Thrust
KIWI B
1961-64
1000 MWt
50 klbf Thrust
Phoebus 1
1965-66
1000 - 1500 MWt
50 - 75 klbf Thrust
Phoebus 2
1967-68
5000 MWt
250 klbf Thrust
NRX series begins (6 system tests)
as part of the NERVA program

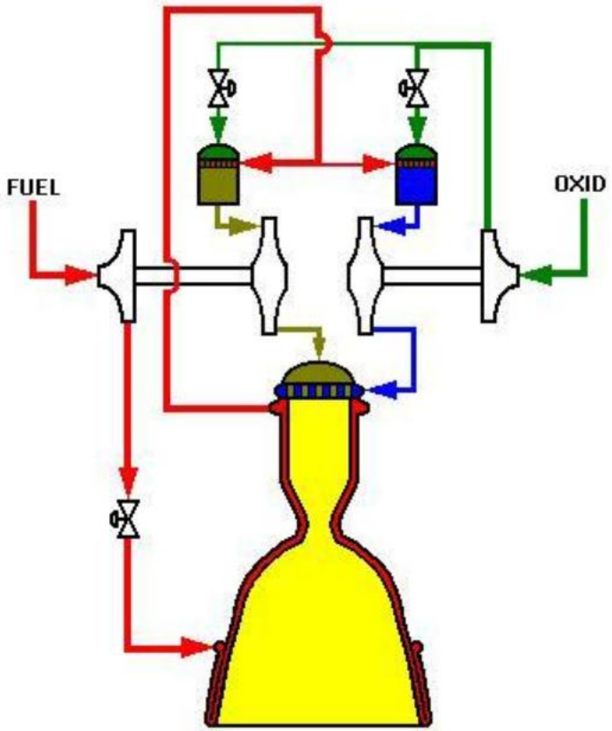

UNITED STATES OF AMERICA

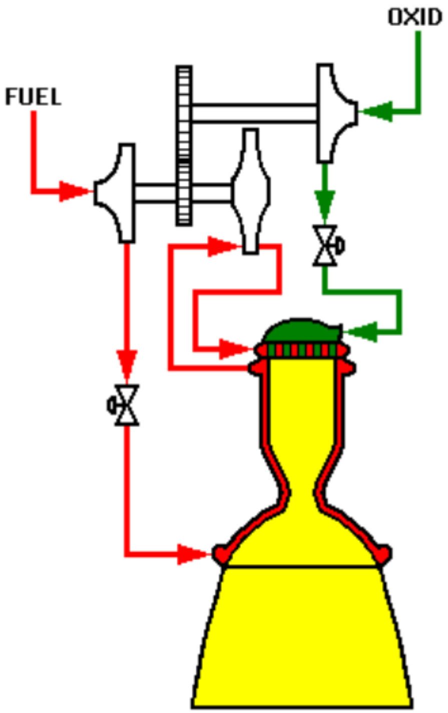

United States
United States



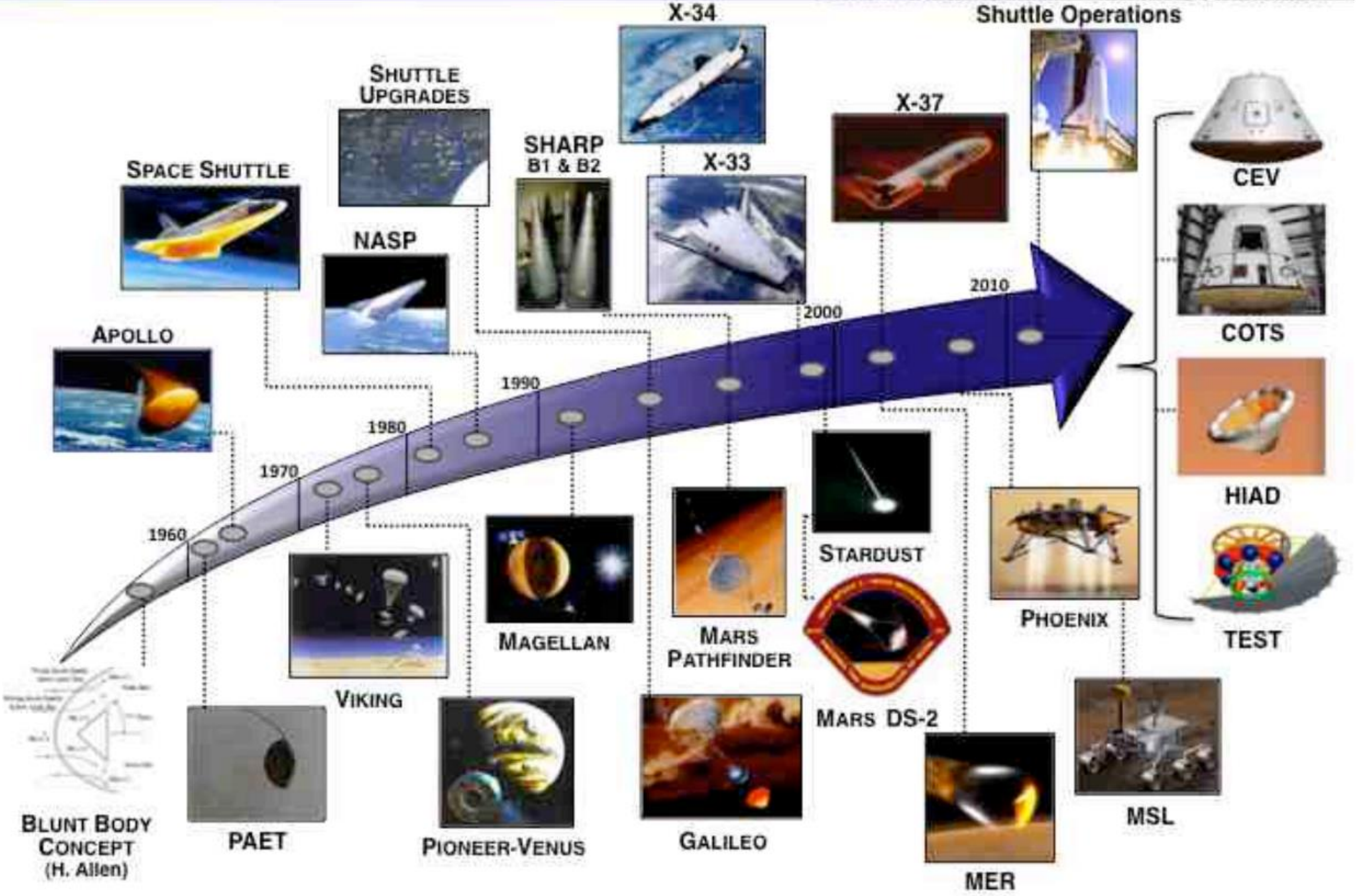


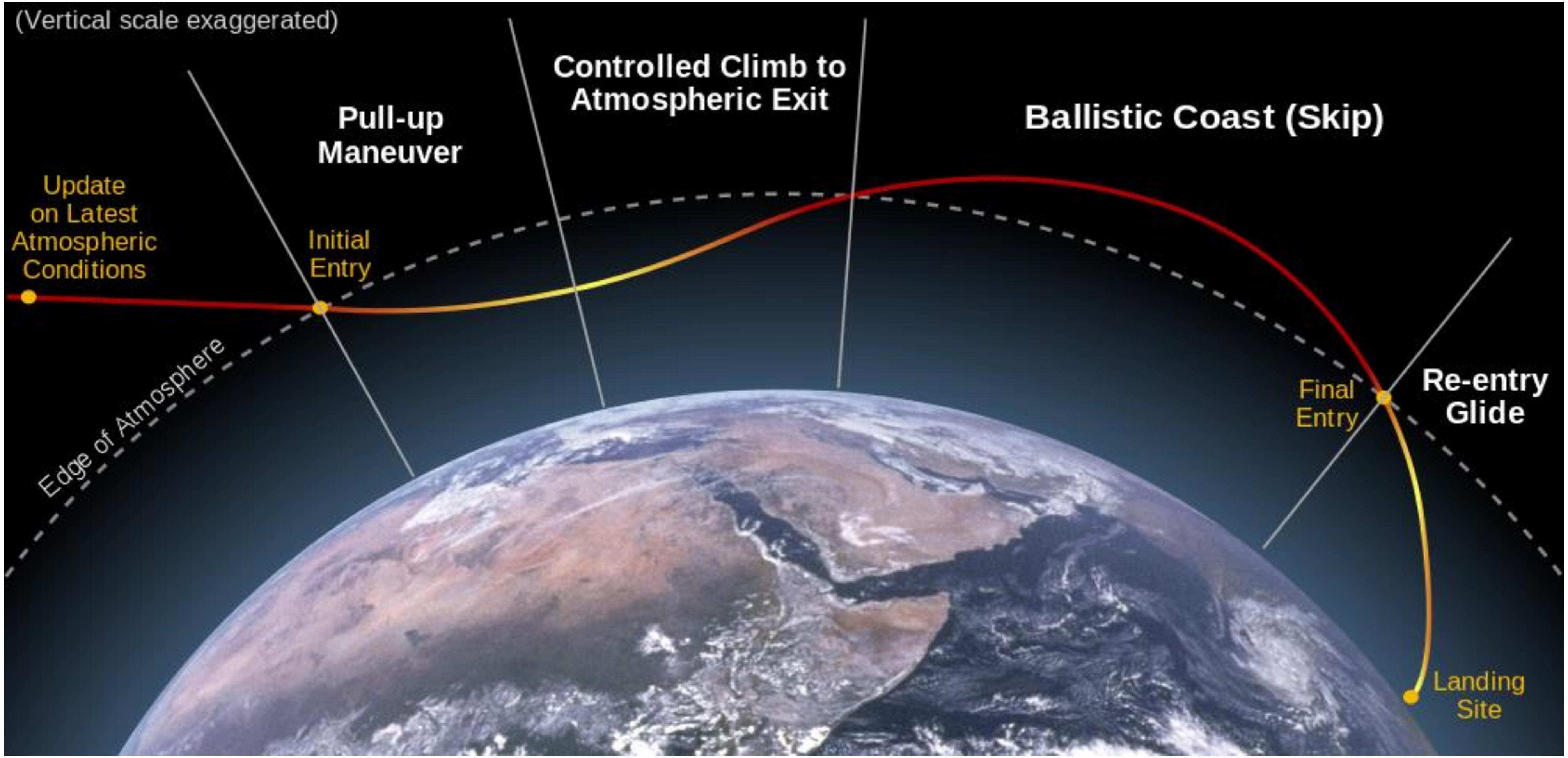

FUEL
OXID


FUEL
OXID

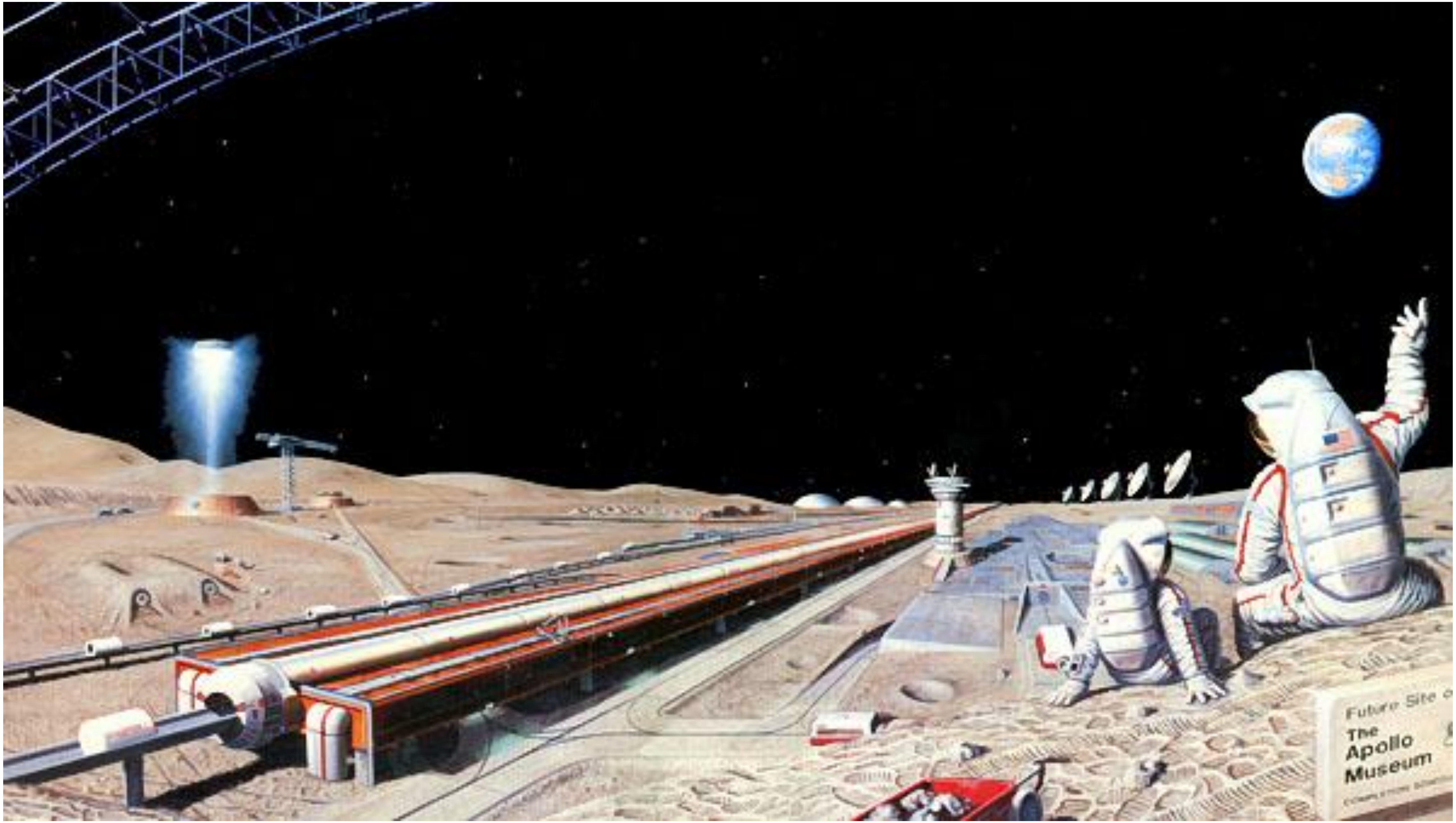

OXID
FUEL

NASA Entry Vehicles / Missions Supported by Ames




(Vertical scale exaggerated)
Controlled Climb to Atmospheric Exit
Pull-up Maneuver
Ballistic Coast (Skip)
Update on Latest Atmospheric Conditions
Initial Entry
Edge of Atmosphere
Final Entry
Re-entry Glide
Landing Site

Booster	Payload	Stage 1	Stage 2	Other	Total	Price
Conventional	20 tons	$90M	$30M	$80M	$200M	$10,000/kg
Falcon 9 Expendable	20	60	20	40	$120M	$6,000/kg
Falcon 9 Reusable Stage 1	20	0	20	40	$60M	$3,000/kg
Falcon 9 Reusable	20	0	0	40	$40M	$2,000/kg
Starship	160	0	0	40	$40M	$250/kg
Falcon 9 Reusable 10X Flights	20	0	0	4	$4M	$200/kg
Starship 10X Flights	160	0	0	0	$4M	$25/kg


Future Site
The
Apollo
Museum

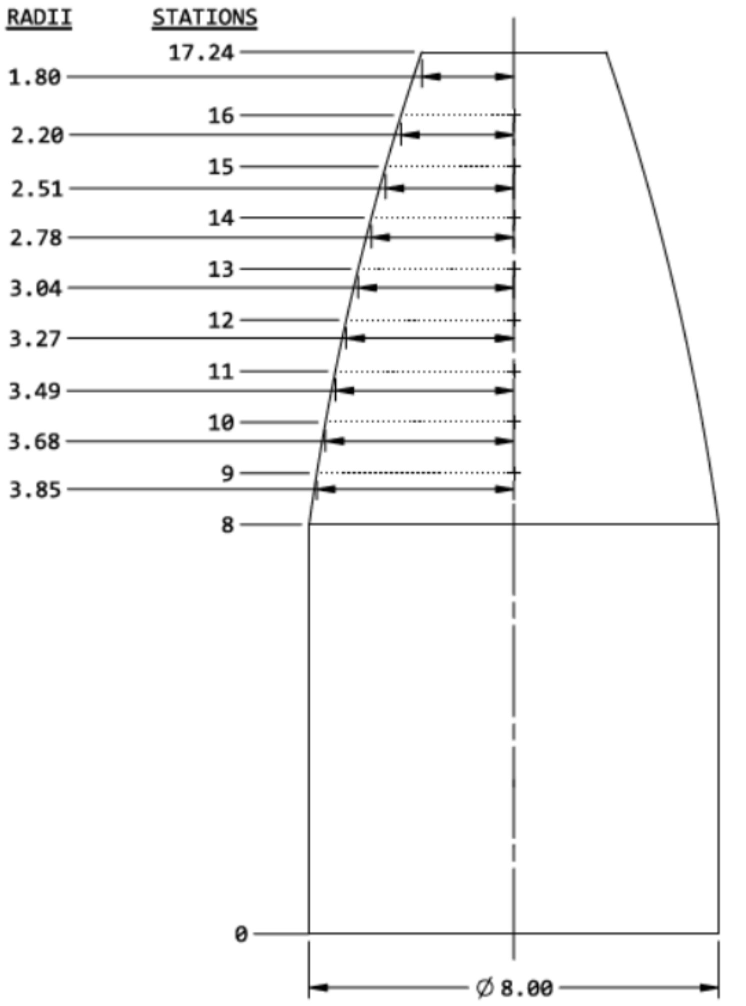
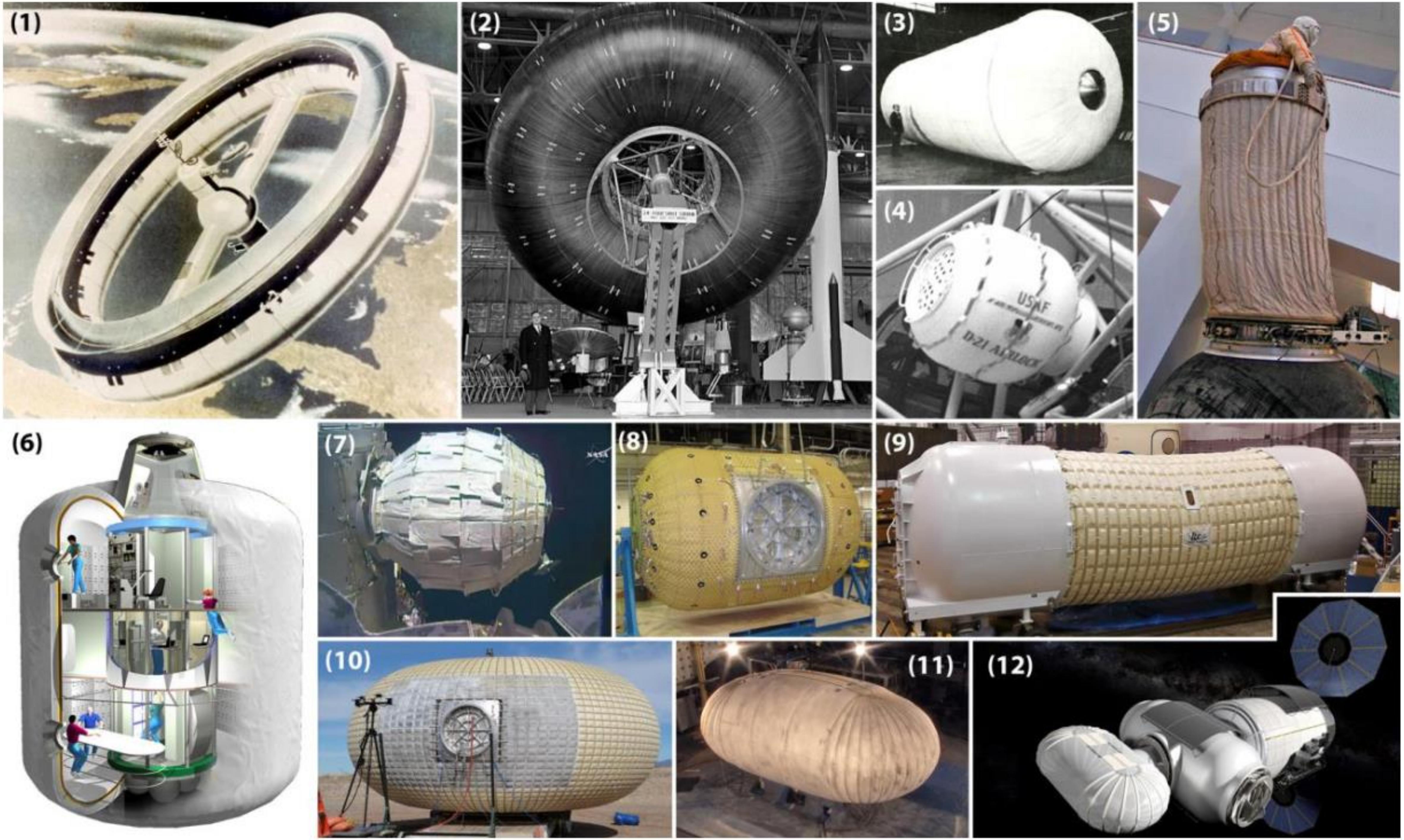
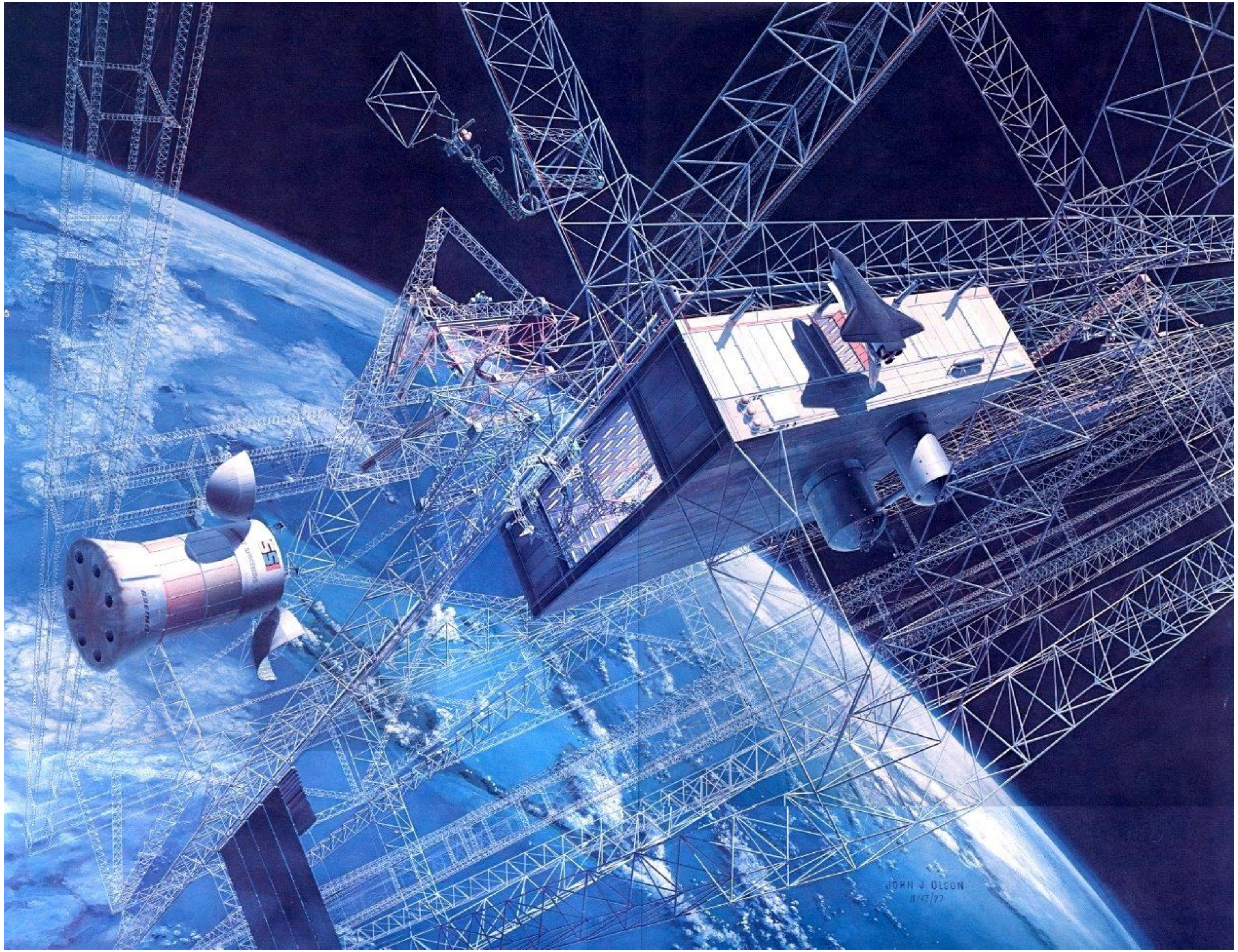
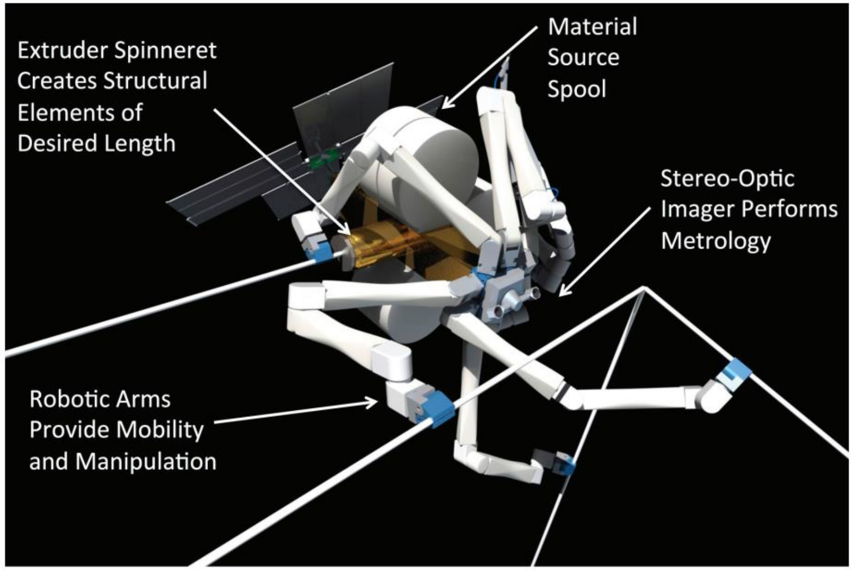
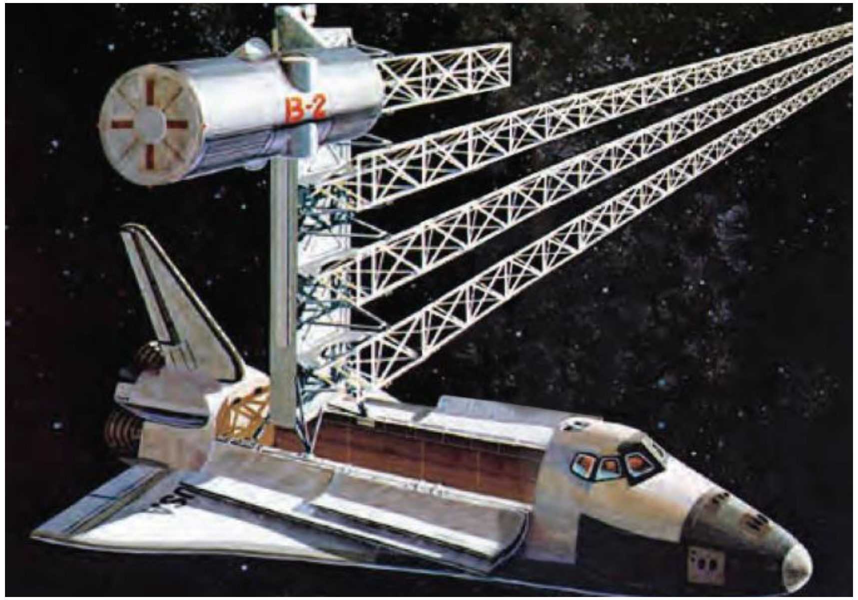


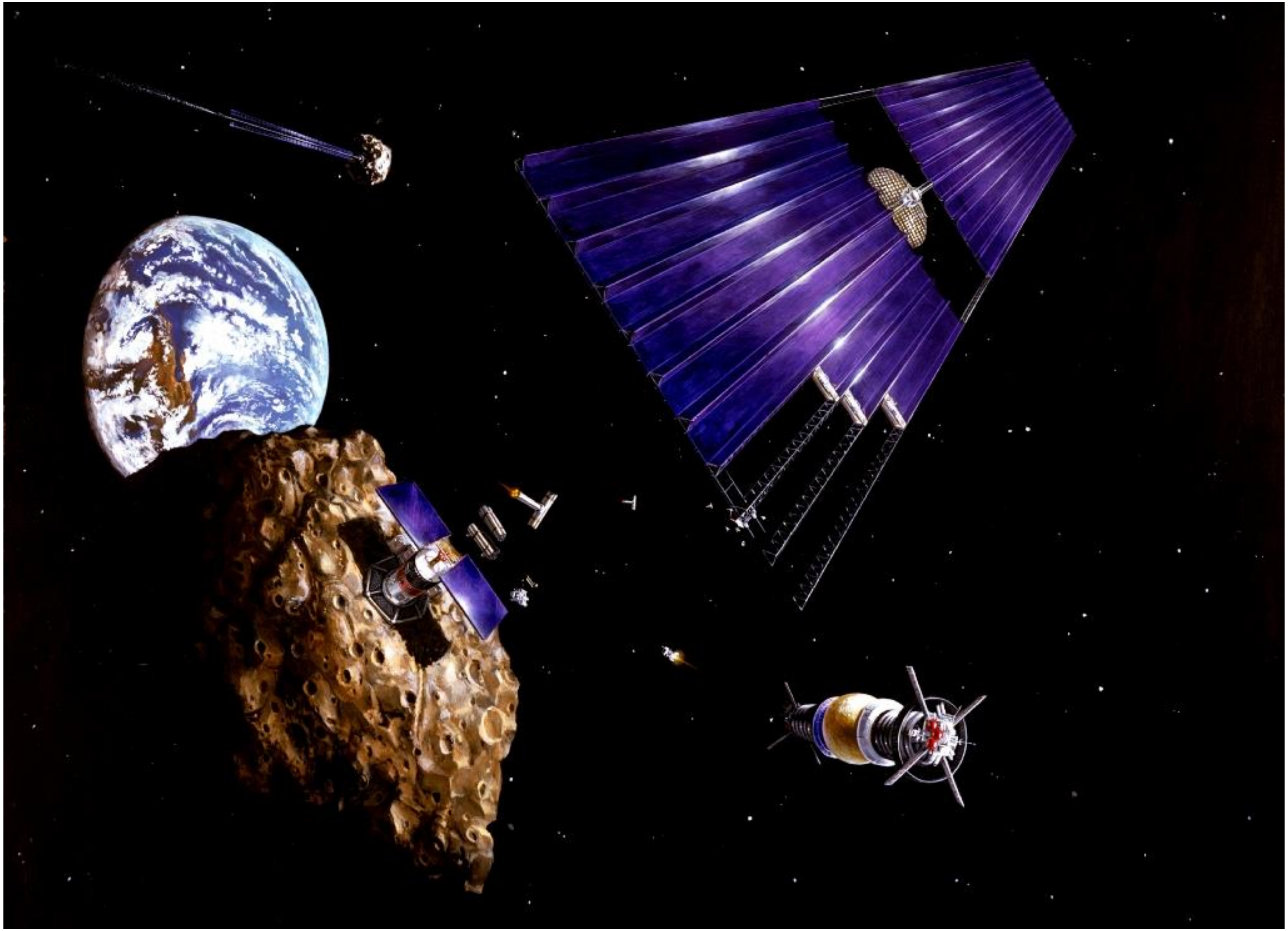
Figure 4: Starship payload volume (dimensions in m)


(1)
(2)
(3)
(4)
USAF
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)

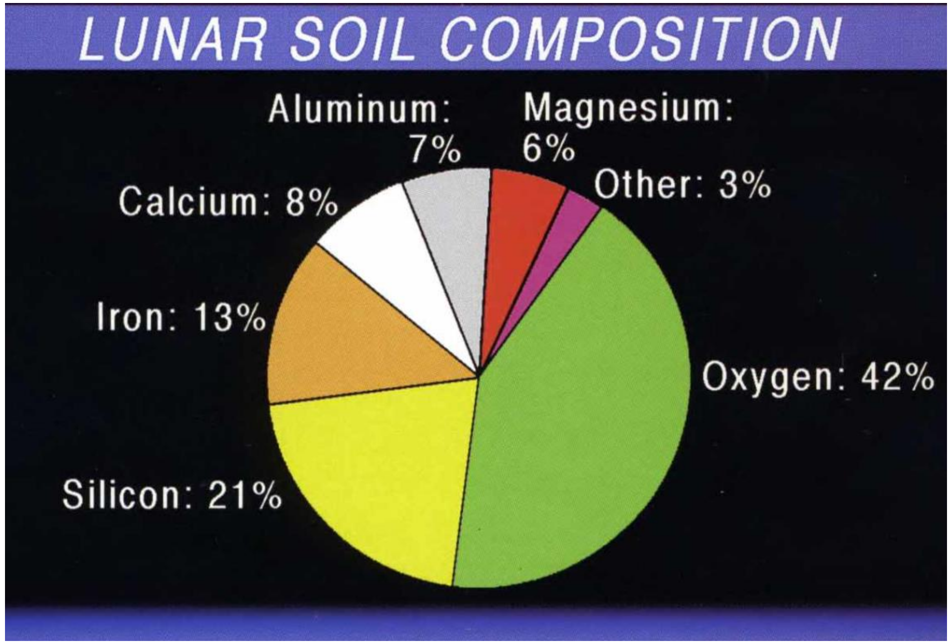


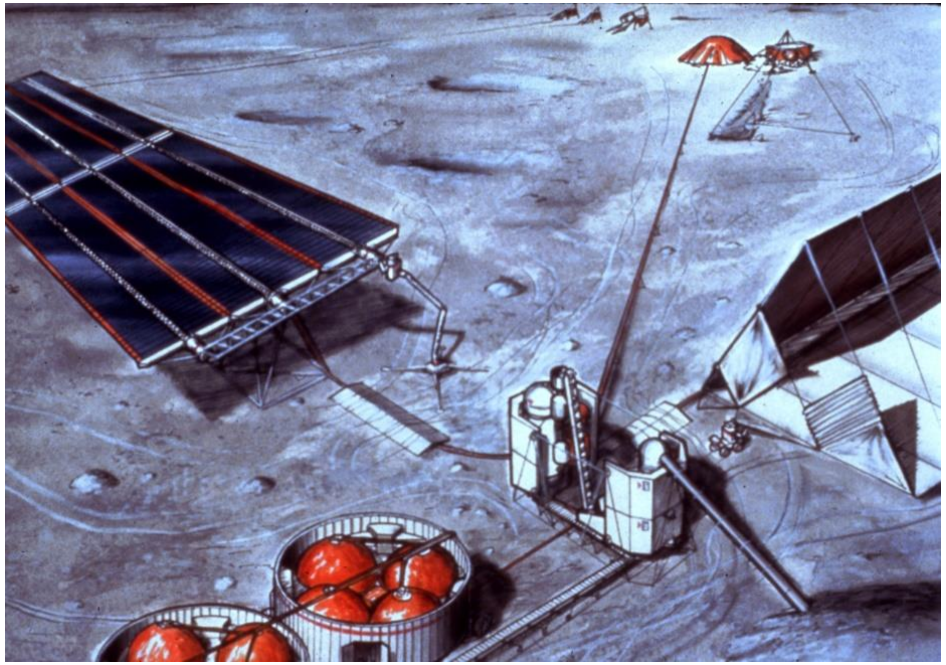

Extruder Spinneret
Creates Structural
Elements of
Desired Length
Material
Source
Spool
Stereo-Optic
Imager Performs
Metrology
Robotic Arms
Provide Mobility
and Manipulation

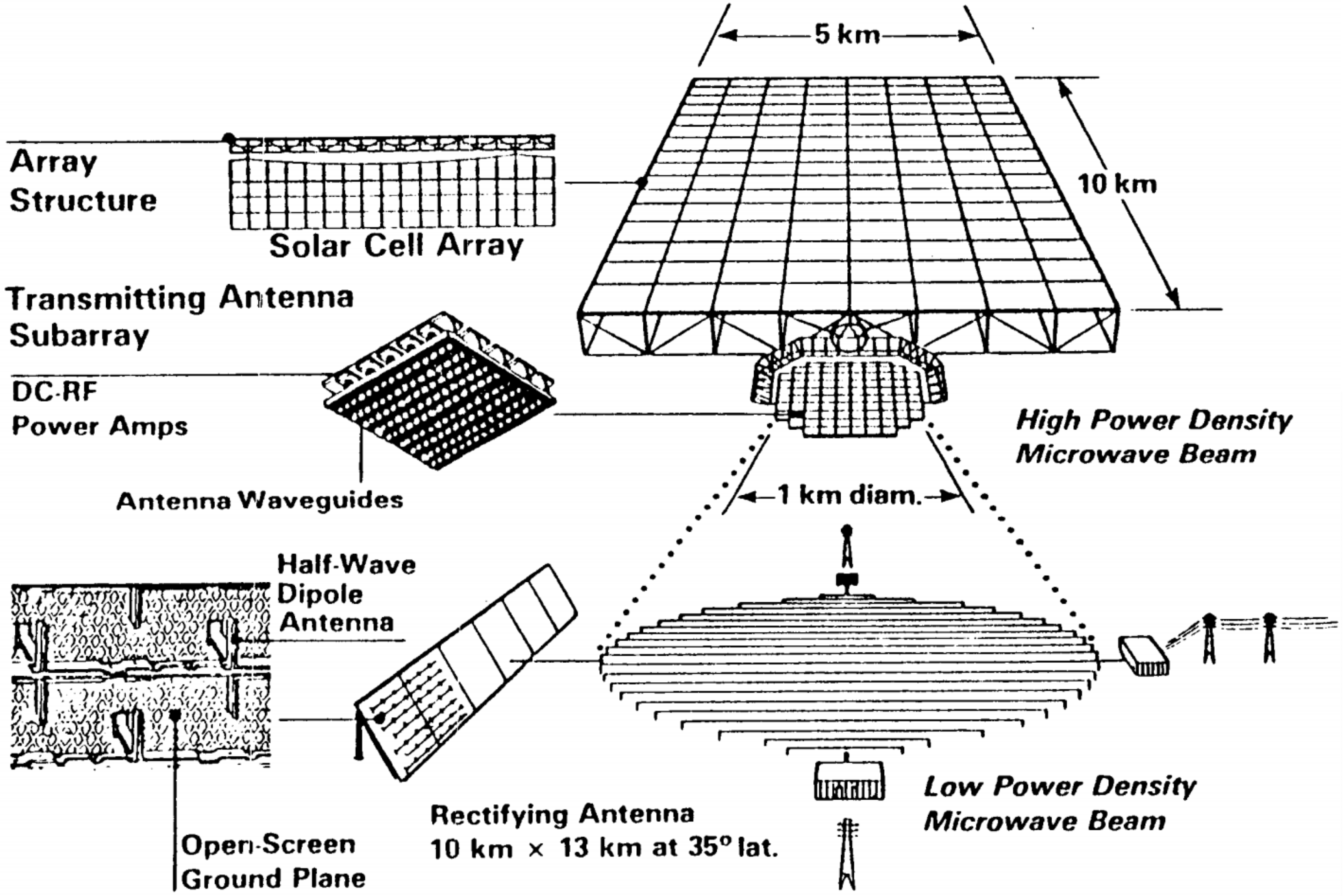

B-2

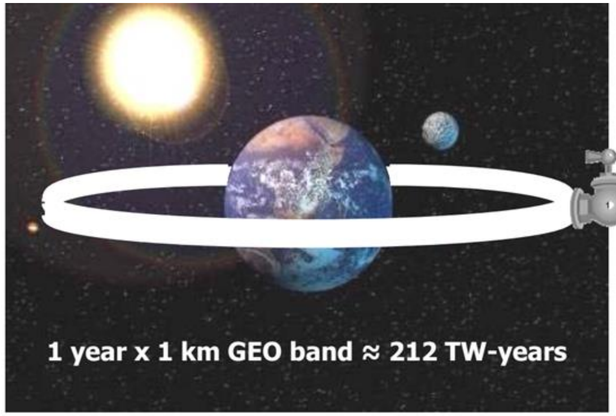


Volatile	Concentration ppm (µg/g)	Average mass per m^3 of regolith (g)
H	46 ± 16	76
^{3}He	0.0042 ± 0.0034	0.007
^{4}He	14.0 ± 11.3	23
C	124 ± 45	206
N	81 ± 37	135
F	70 ± 47	116
Cl	30 ± 20	50

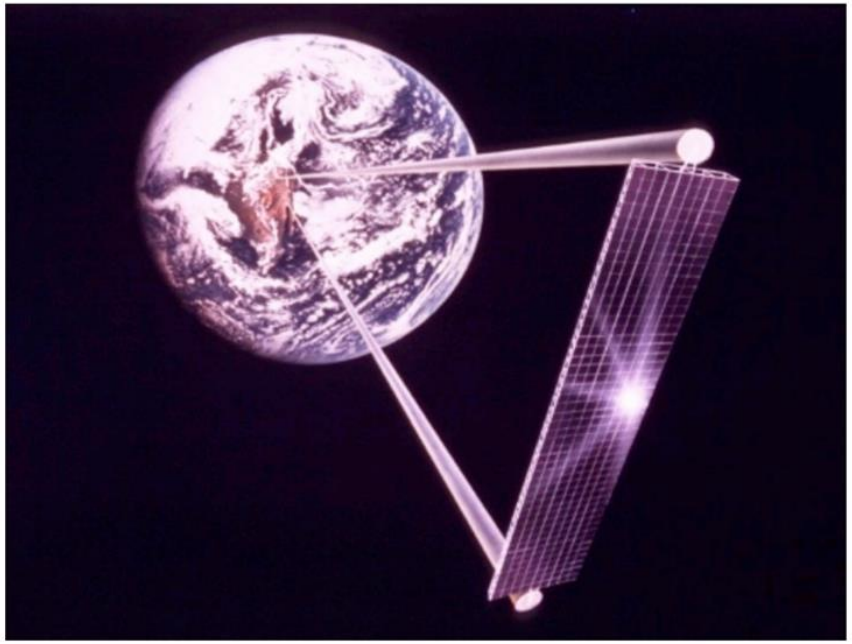


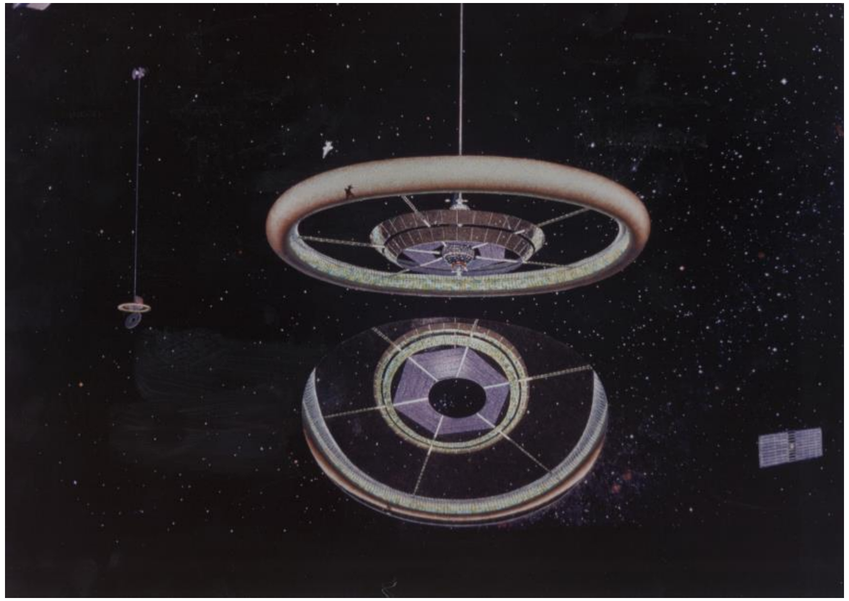
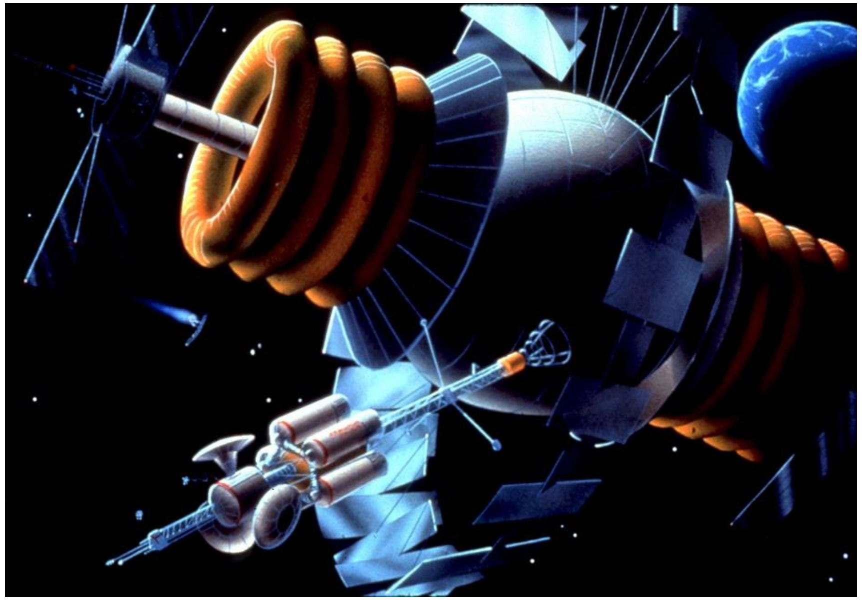
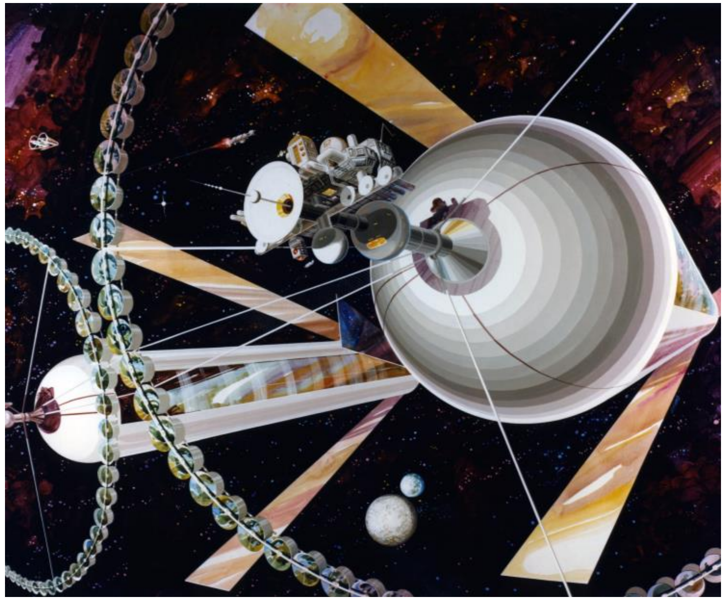


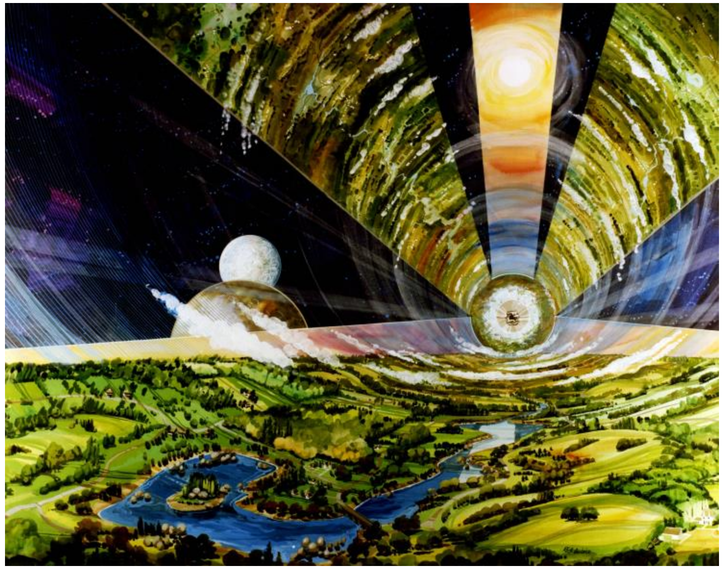




Every 1 km-wide insolation band at GEO receives nearly as much energy per annum as the content of the entire 1.28T BBLs of recoverable oil remaining

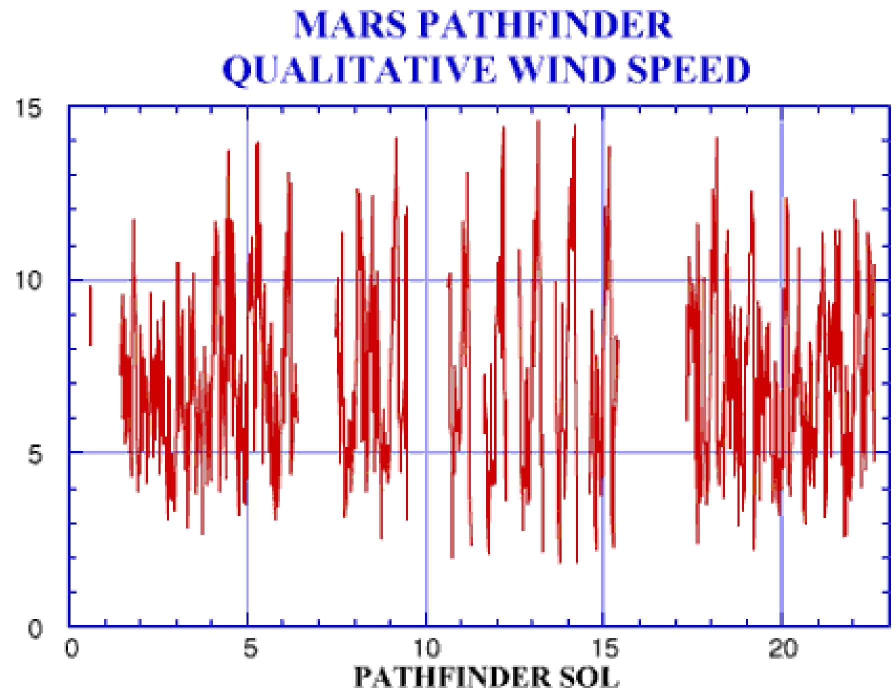


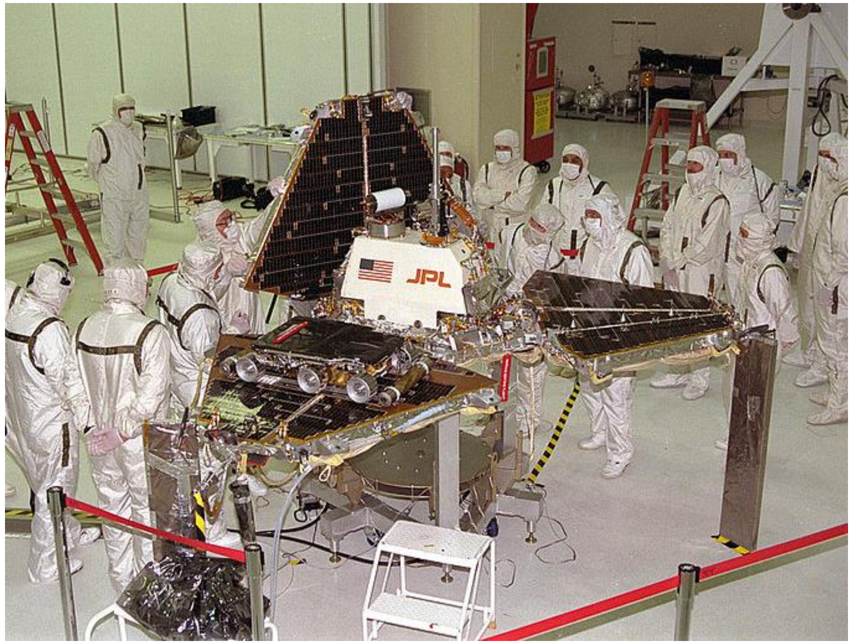

NASA
WE NEED YOU

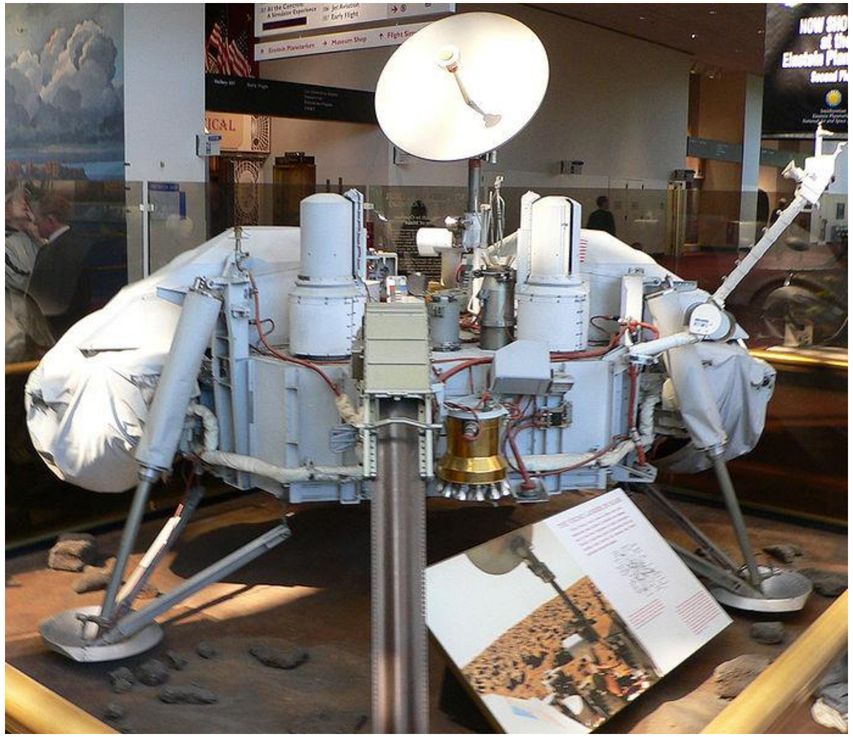
τ = 0.94
2.9
4.1
3.8
4.7
1205
11:14
1220
11:04
1225
11:30
1233
10:55
1235
10:53
Opportunity Sol Number and Local True Solar Time



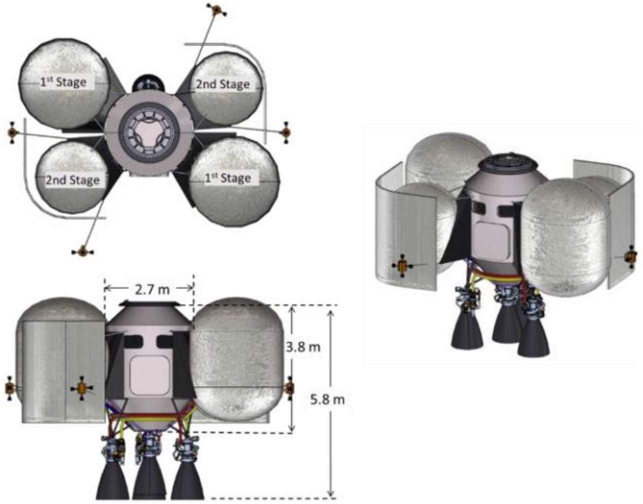
Wind speed on Mars		R. Pappa	"Feels like" wind speed on Earth (at STP)	
mph	m/s	dynamic pressure (Pa)	m/s	mph
10	4.5	0.2367	0.6	1.4
50	22.4	5.9169	3.0	6.8
67	30.0* +	10.6587	4.1	9.1
100	44.7	23.6677	6.1	13.5
150	67.1	53.2523	9.1	20.3
200	89.4	94.6708	12.1	27.1
224	100.0	118.4304	13.5	30.3
447	200.0	473.7216	27.1	60.6
500	223.5	591.6924	30.3	67.7

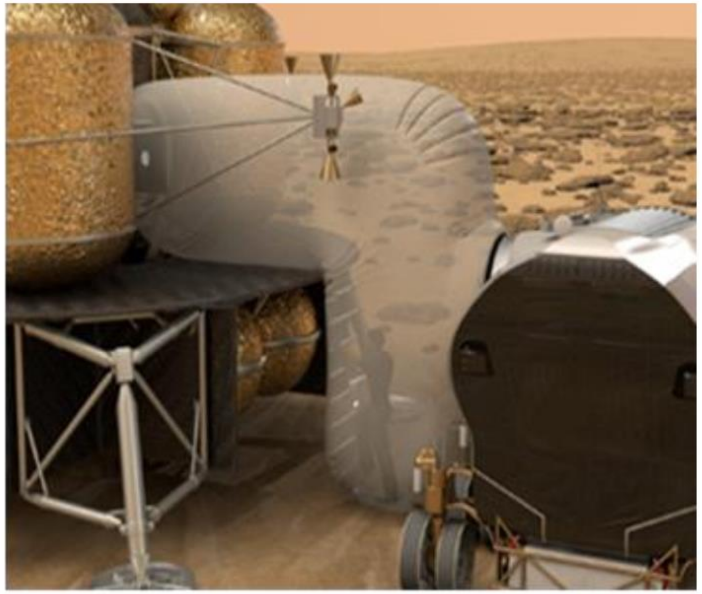
* Highest measured wind speed from Viking Lander (1.6 m sensor elevation)

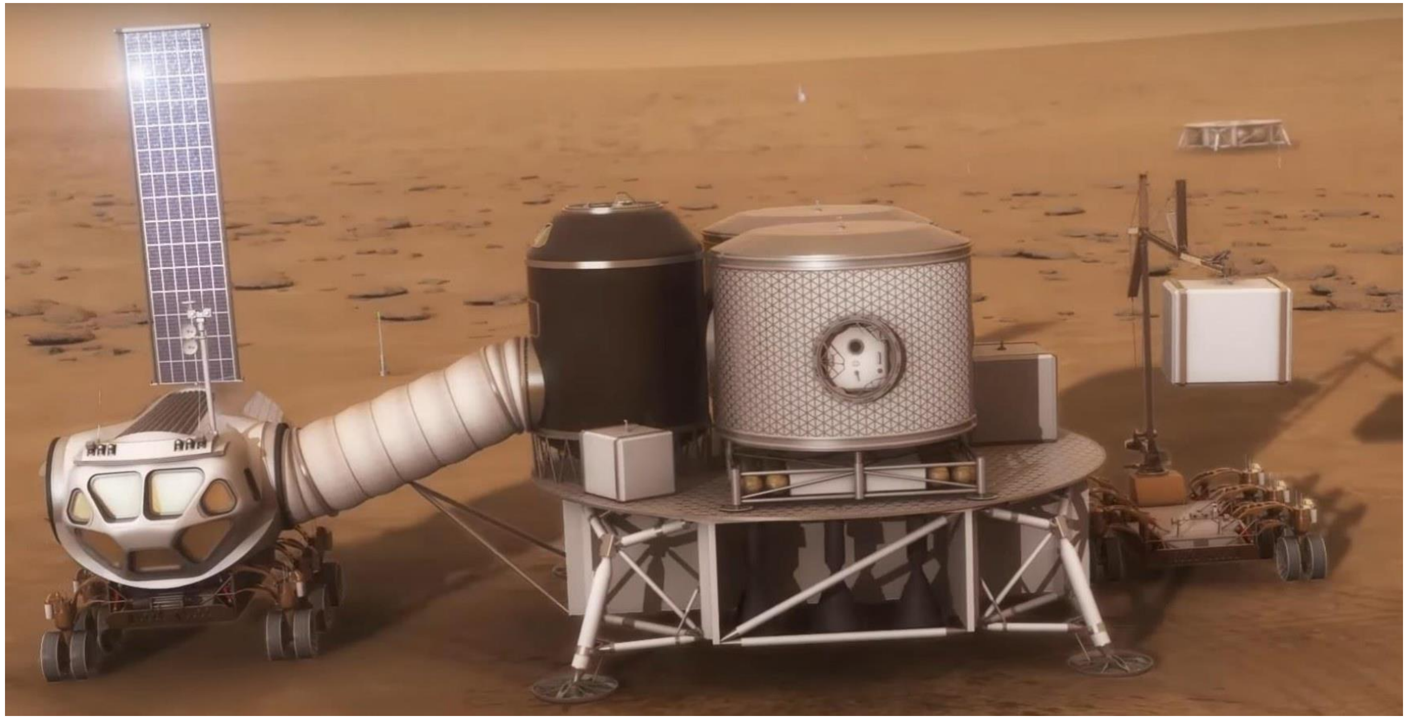




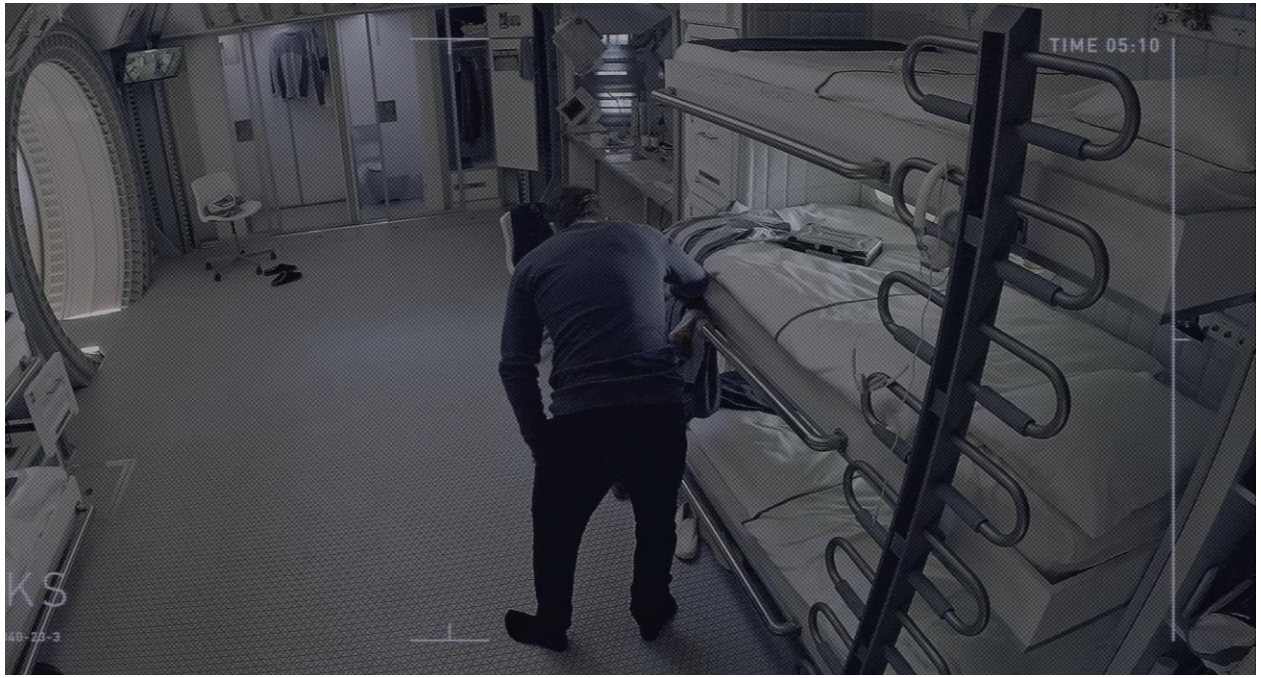

NASA
ARES IV MAV

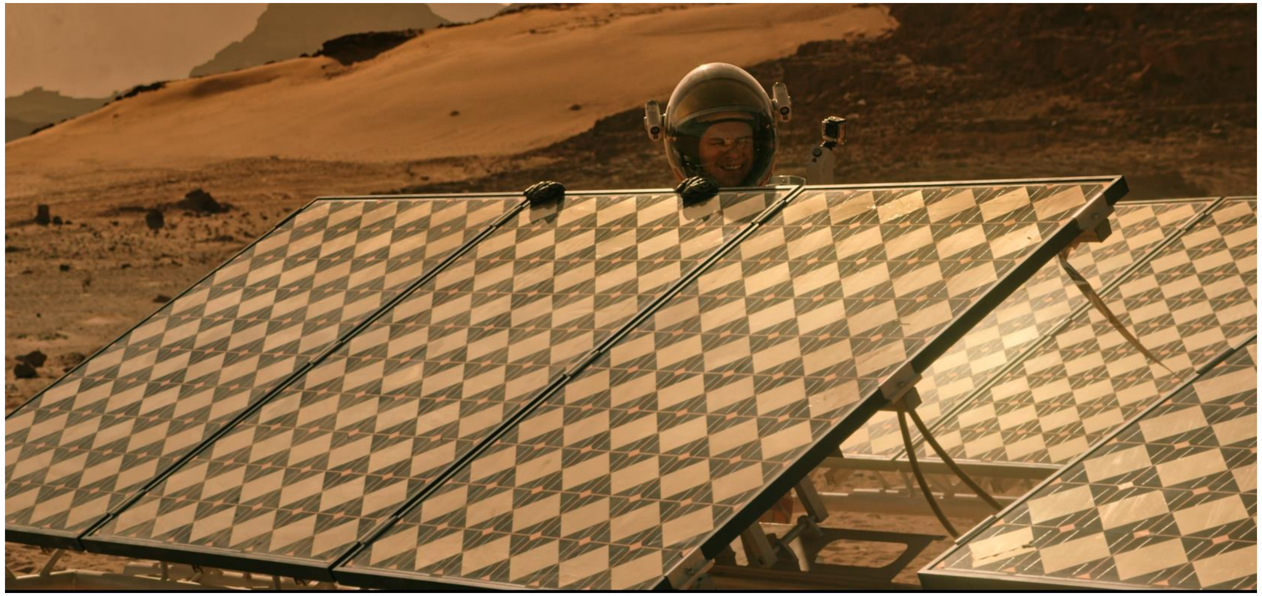

1st Stage
2nd Stage
2nd Stage
1st Stage
2.7 m
3.8 m
5.8 m






4.1m
3.7m
6m


TIME 05:10



Primary Resources of Interest for Human Exploration

	Moon	Mars	Asteroids	Uses
Water (Hydrogen)	Icy Regolith in Permanently Shadowed Regions (PSR) Solar wind hydrogen with Oxygen	Hydrated Soils/Minerals: Gypsum, Jarosite, Phylosilicates, Polyhdrated Sulfates Subsurface Icy Soils in Mid-latitudes to Poles	Subsurface Regolith on C-type Carbonaceous Chondrites	▪ Drinking, radiation shielding, plant growth, cleaning & washing ▪ Making Oxygen and Hydrogen
Oxygen	Minerals in Lunar Regolith: Ilmenite, Pyroxene, Olivine, Anorthite	Carbon Dioxide in the atmosphere (~96%)	Minerals in Regolith on S-type Ordinary and Enstatite Chondrites	▪ Breathing ▪ Oxidizer for Propulsion and Power
Carbon (Gases)	▪ CO, CO_2, and HC's in PSR ▪ Solar Wind from Sun (~50 ppm)	Carbon Dioxide in the atmosphere (~96%)	Hydrocarbons and Tars (PAHs) in Regolith on C-type Carbonaceous Chondrites	▪ Fuel Production for Propulsion and Power ▪ Plastic and Petrochemical Production
Metals	Minerals in Lunar Regolith ▪ Iron/Ti: Ilmenite ▪ Silicon: Pyroxene, Olivine, Anorthite ▪ Magnesium: Mg-rich Silicates ▪ Al: Anorthitic Plagioclase	Minerals in Mars Soils/Rocks ▪ Iron: Ilmenite, Hematite, Magnetite, Jarosite, Smectite ▪ Silicon: Silica, Phyllosilicates ▪ Aluminum: Laterites, Aluminosilicates, Plagioclase ▪ Magnesium: Mg-sulfates, Carbonates, & Smectites, Mg-rich Olivine	Minerals in Regolith/Rocks on S-type Stony Iron and M-type Metal Asteroids	▪ *In situ* fabrication of parts ▪ Electical power generation and transmission

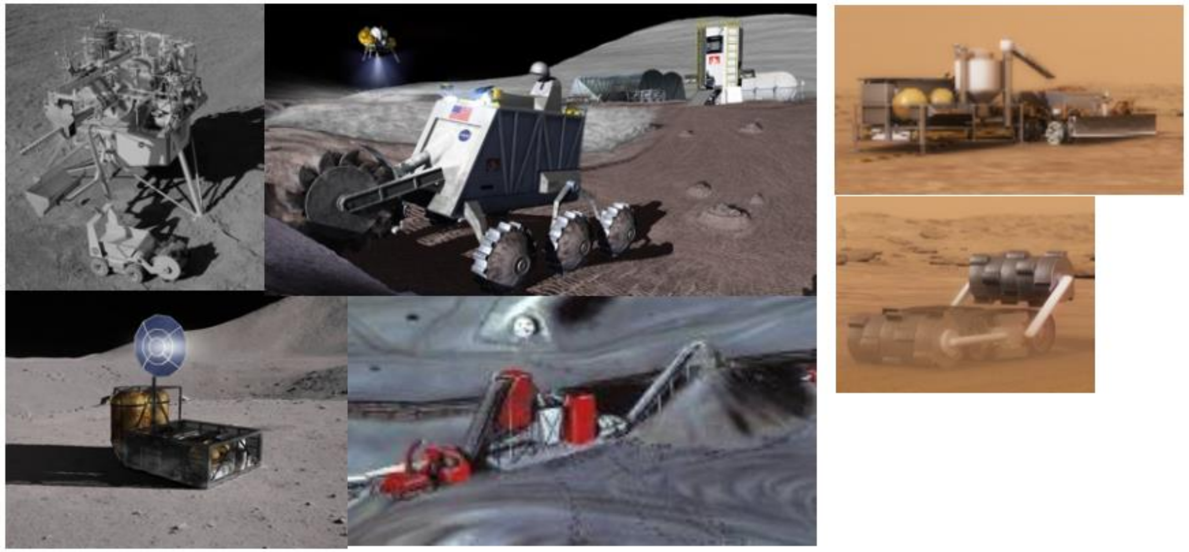
Note: Rare Earth Elements (REE) and Platinum Group Metals (PGM) are not driving Resources of interest for Human Exploration

Resource Prospecting – Looking for Water
Hydrated minerals & subsurface ice on Mars

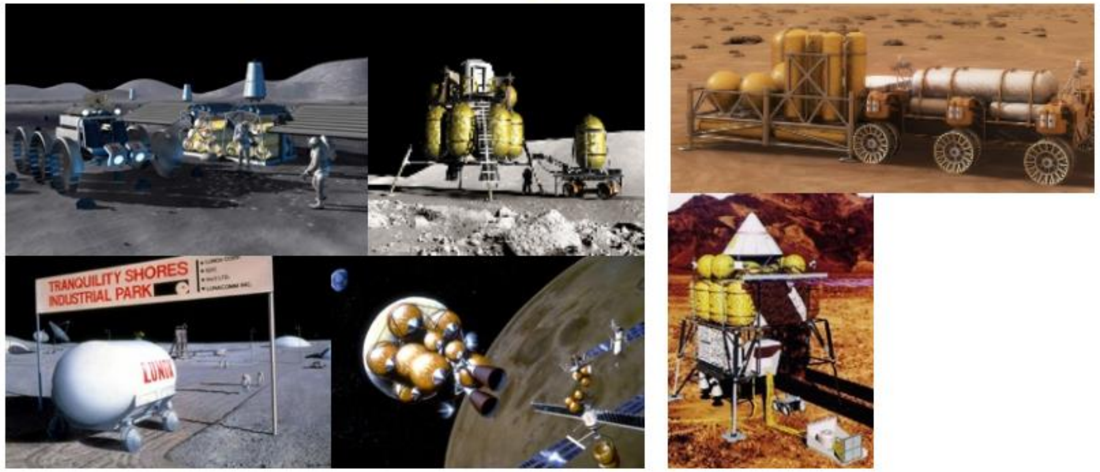
Mining Polar Water & Volatiles
Mining near surface ice on Mars

Landing Pads, Berms, Roads, and Structure Construction

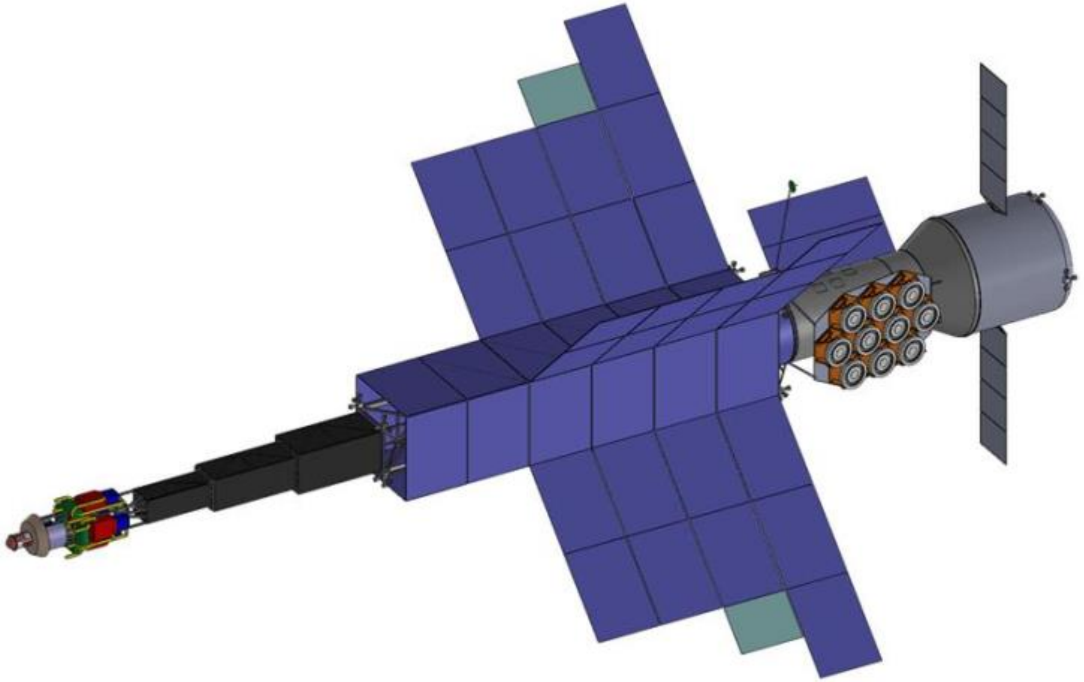
Excavation & Regolith Processing for O_2 Production
Excavation & Processing for H_2O Extraction

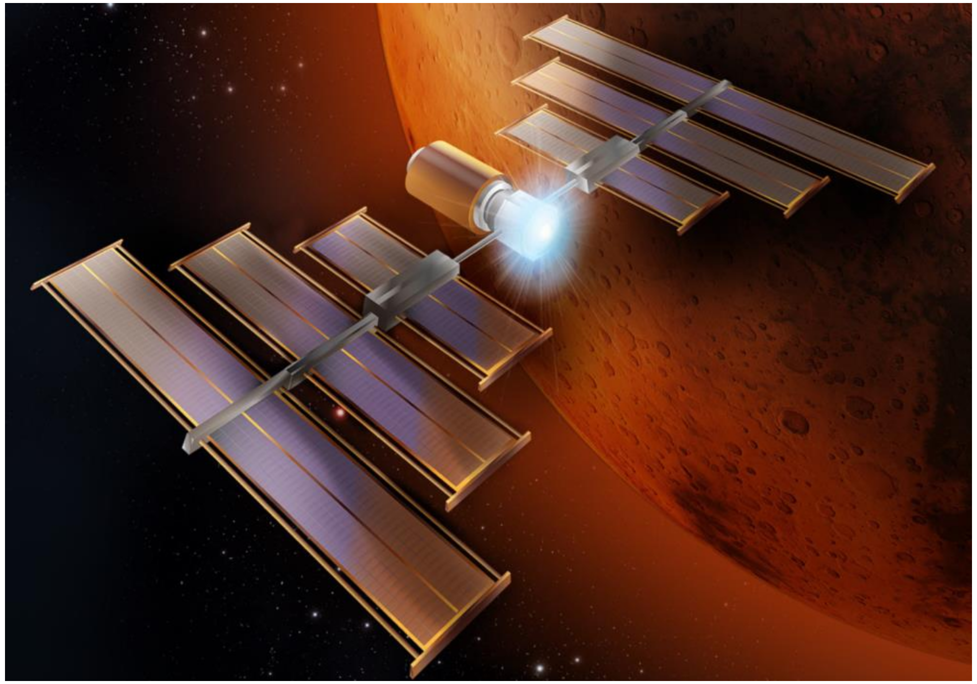


Refueling and Reusing Landers & Rovers









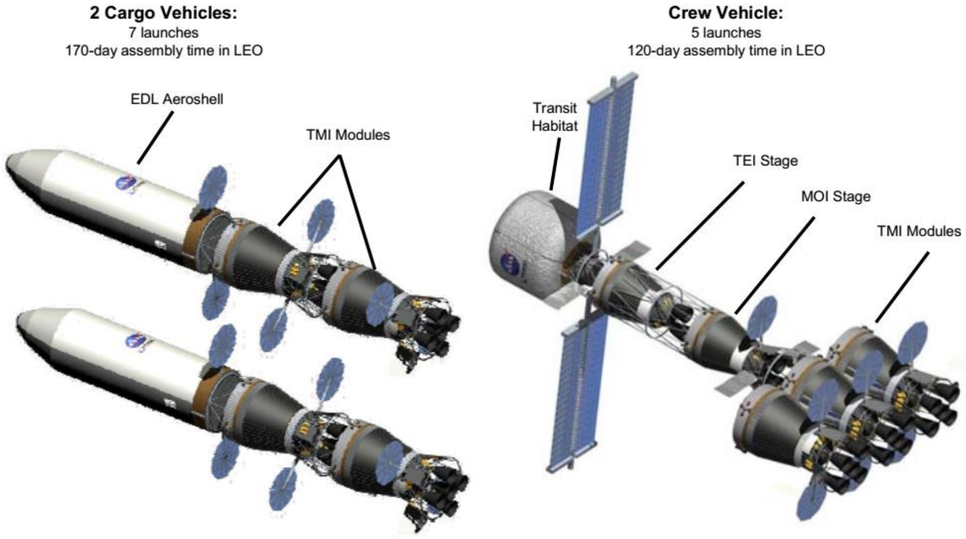


Figure 4-6. Chemical/aerobrake cargo and crewed MTV concepts.