国内外の天文飛翔体計画及び将来計画（JAXA/NASA/ESA/NAOJ）

Future Space Science Program of JAXA

Toru Yamada
Director, Division of Astronomy and Astrophysics, ISAS. JAXA

On-going Science Programs of ISAS/JAXA

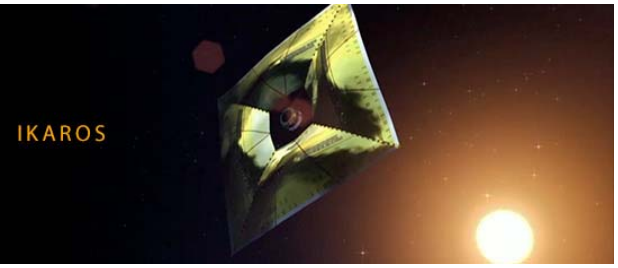
Hayabu

No Astrophysical Satellite Mission in orbit after the ASTRO-H (Hitomi) mishap

ion and
Radiation in Geospace

AKATSUKI Venus Meteorogy

HISAKI Extreme UV spectroscope for Exosphere Dynamics

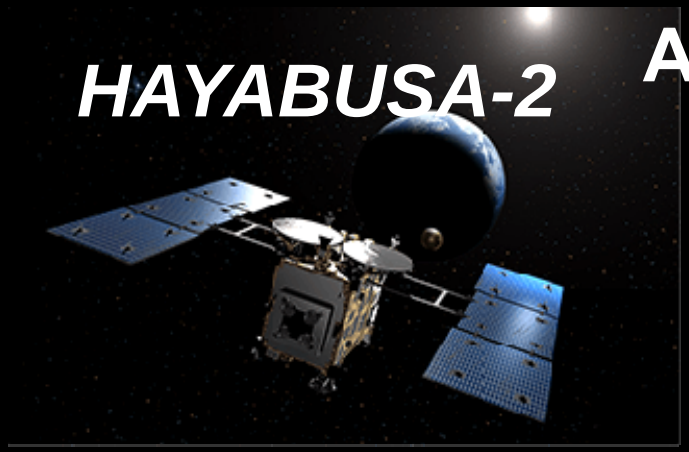


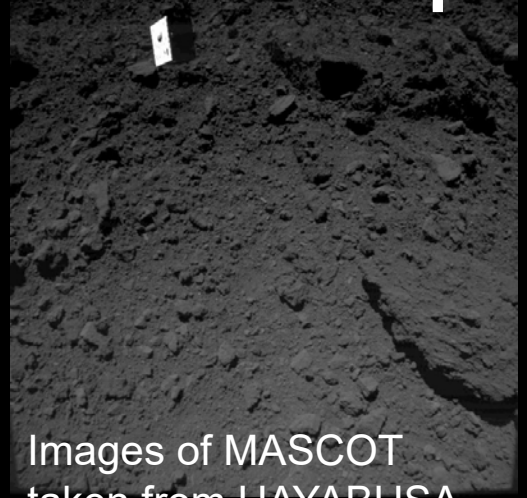
BepiColombo
Euro-Japan Joint Mission
Mercury Exploration

IKAROS Solar Power Sail Demonstrator

GEOTAIL Earth's Magnetosphere

Asteroid Sample-Return Mission





Images of MASCOT
taken from HAYABUSA

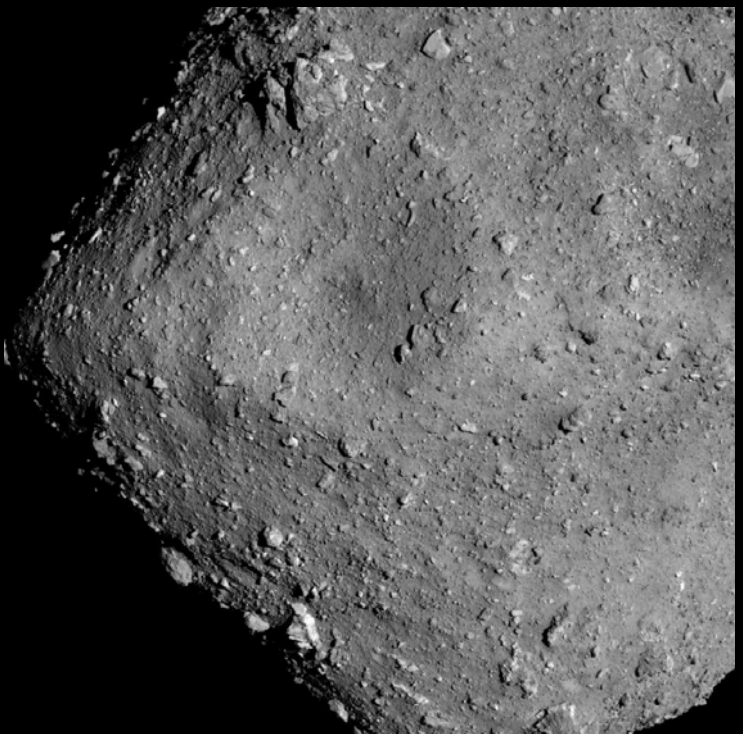
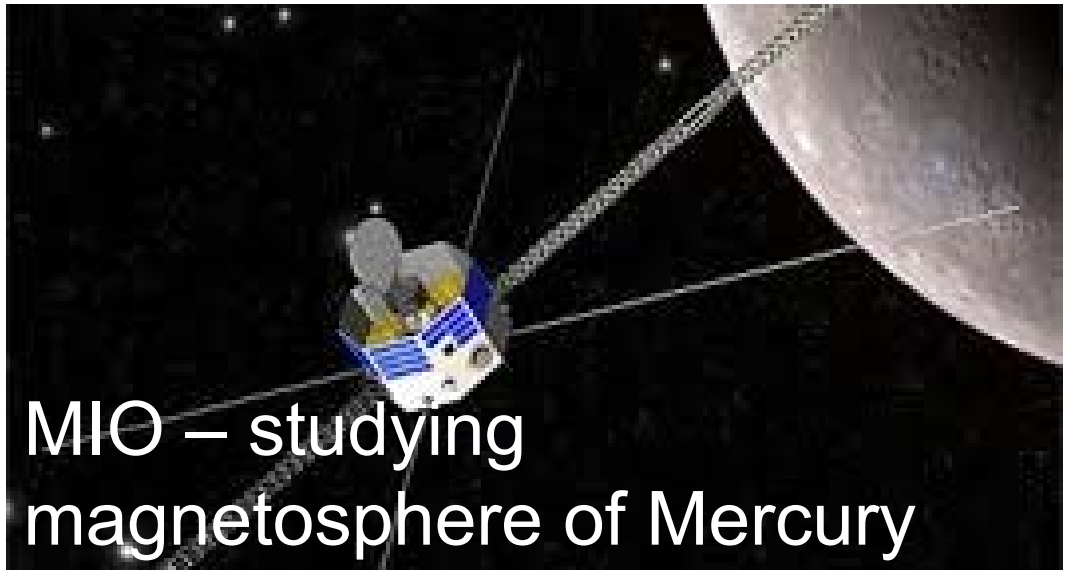
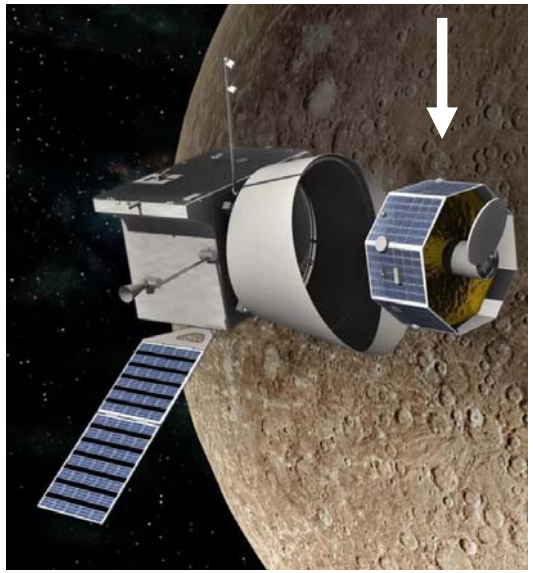


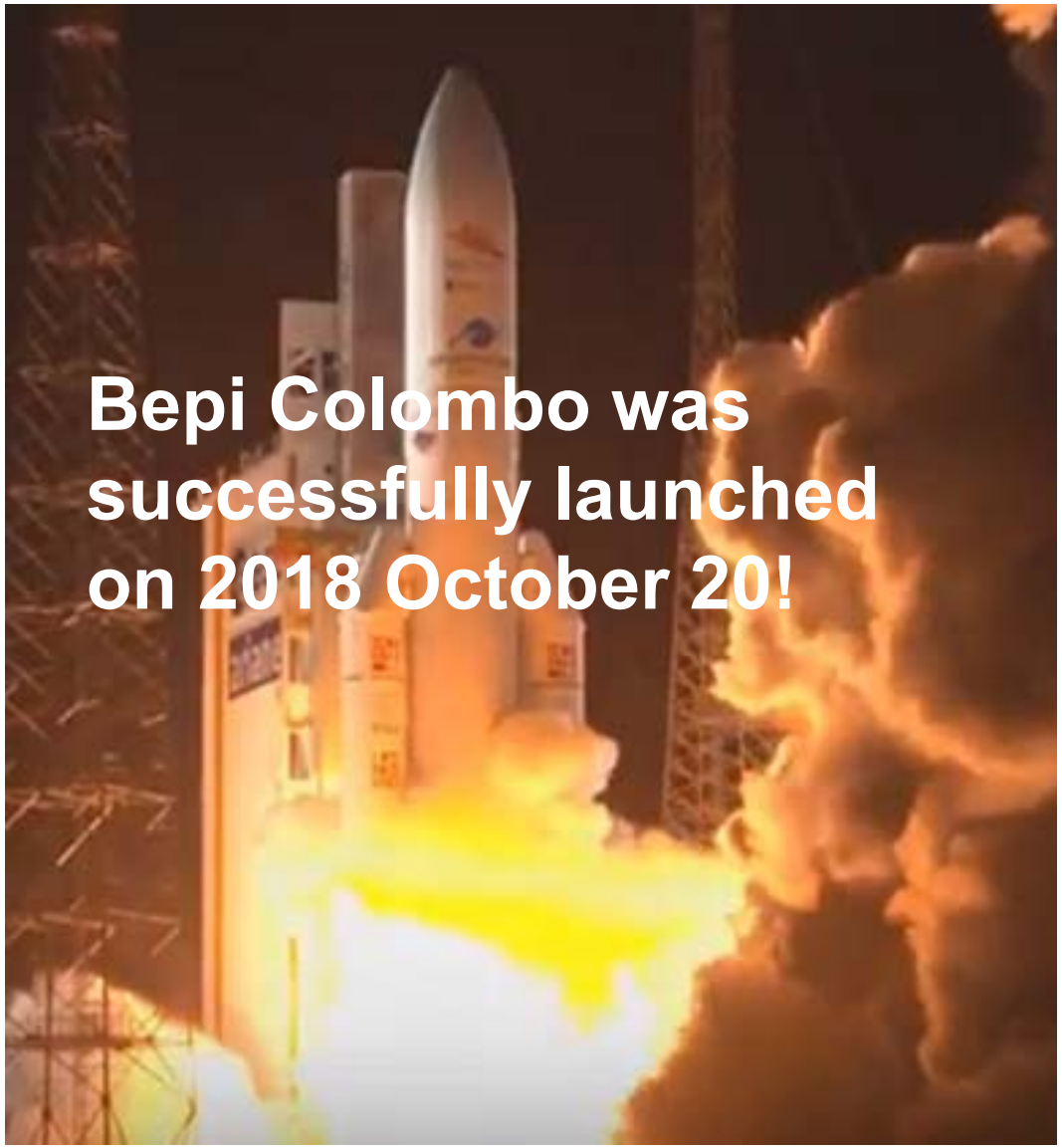
Image taken by
MASCOT

Images taken by MINERVA-I

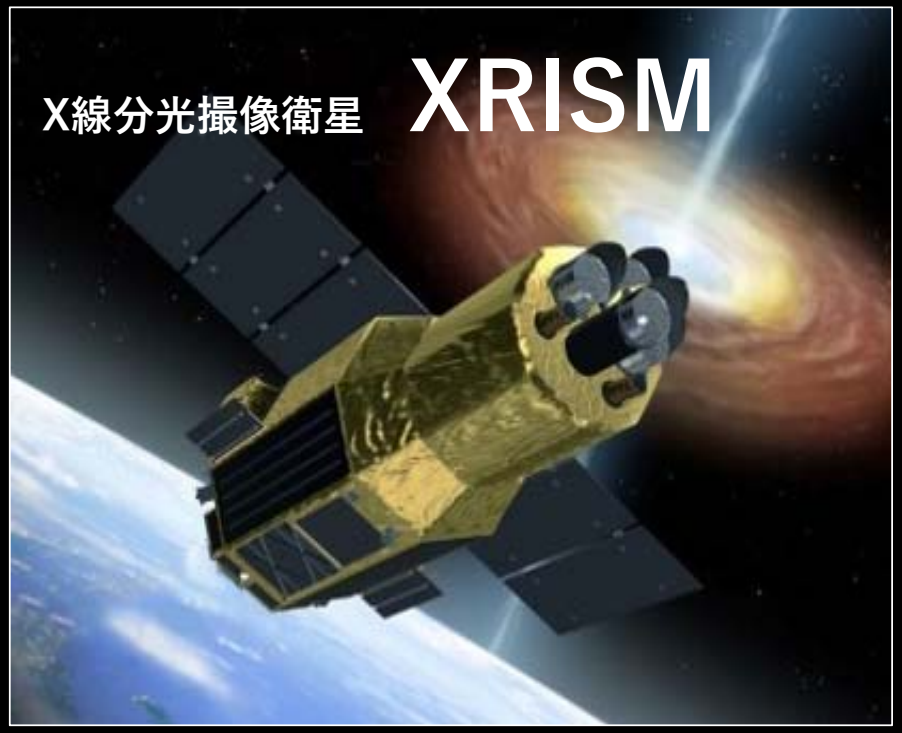


MIO – studying magnetosphere of Mercury

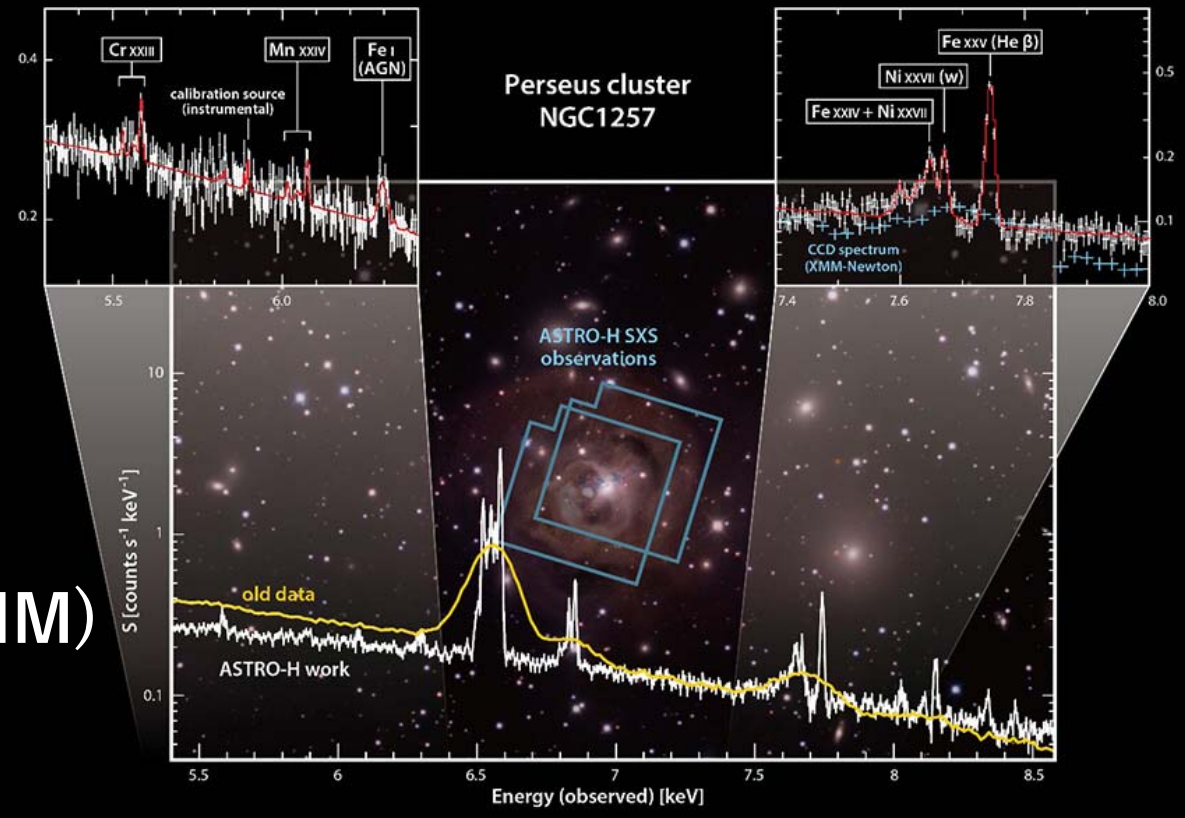




Bepi Colombo was successfully launched on 2018 October 20!



X-ray Imaging and Spectroscopy Mission



Photon energy resolution of
~7eV (goal 5eV) @ 6keV (FWHM)
E/ΔE~1000

Credit: JAXA / NASA / Ken Crawford (Rancho Del Sol Observatory)

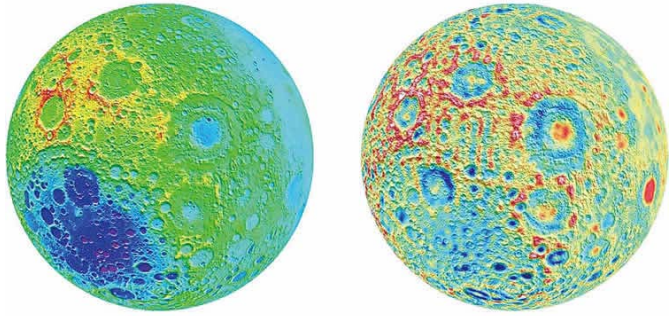
ISAS-NAOJ Collaboration in Space Science

Hinode Mission

- NAOJ
  - Science Payload (SOT/EIS/XRT)
    [w/ International Collaboration]
  - Science Center
- International Science Achievements

RISE Project

- SELENE (Kaguya)
- Science Instruments for
  - Hayabusa-2 LIDAR
  - JUICE GALA

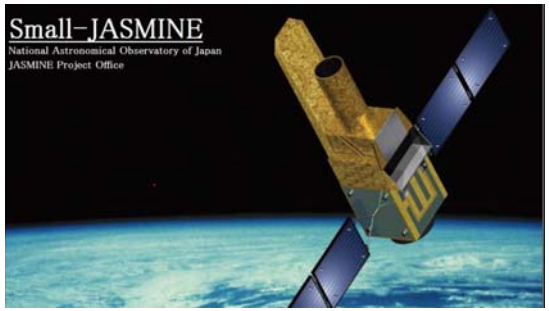


Credit: 国立天文台/千葉工業大学/JAXA

ISAS-NAOJ Collaboration in Space Science

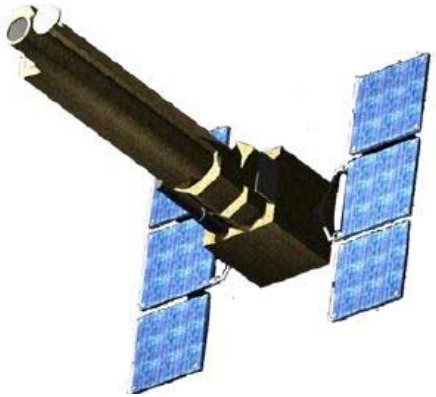
Future Missions and Candidates

Mission Concepts proposed
For Competitive M-Class

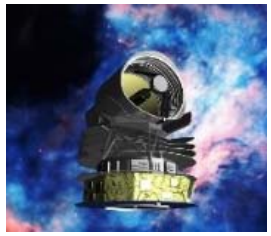


Small JASMINE
JAXA M-3 (selected)

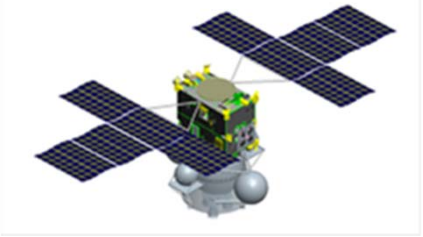
Solar-C_EUVST
JAXA M-4/5 candidate



Data Management

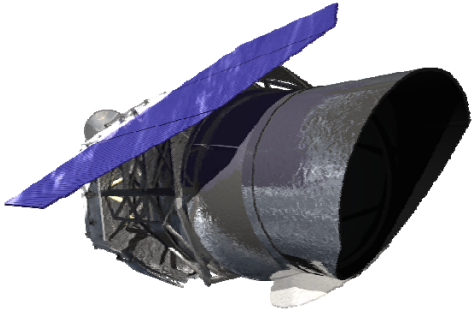


Science Collaboration



International Collaboration Program

NASA WFIRST
Subaru Synergistic Observations



ISAS-NAOJ Collaboration in Space Science

- Fruitful collaboration between NAOJ-ISAS/JAXA in space mission programs [Hinode, Kaguya….]
- Science Collaborations
  Ground-based facilities/Space facilities
  Peer reviews
- Proposed future space missions
  [Small-JASMINE, Solar-C_EUVST, WFIRST…]

ISAS-NAOJ Collaboration in Space Science

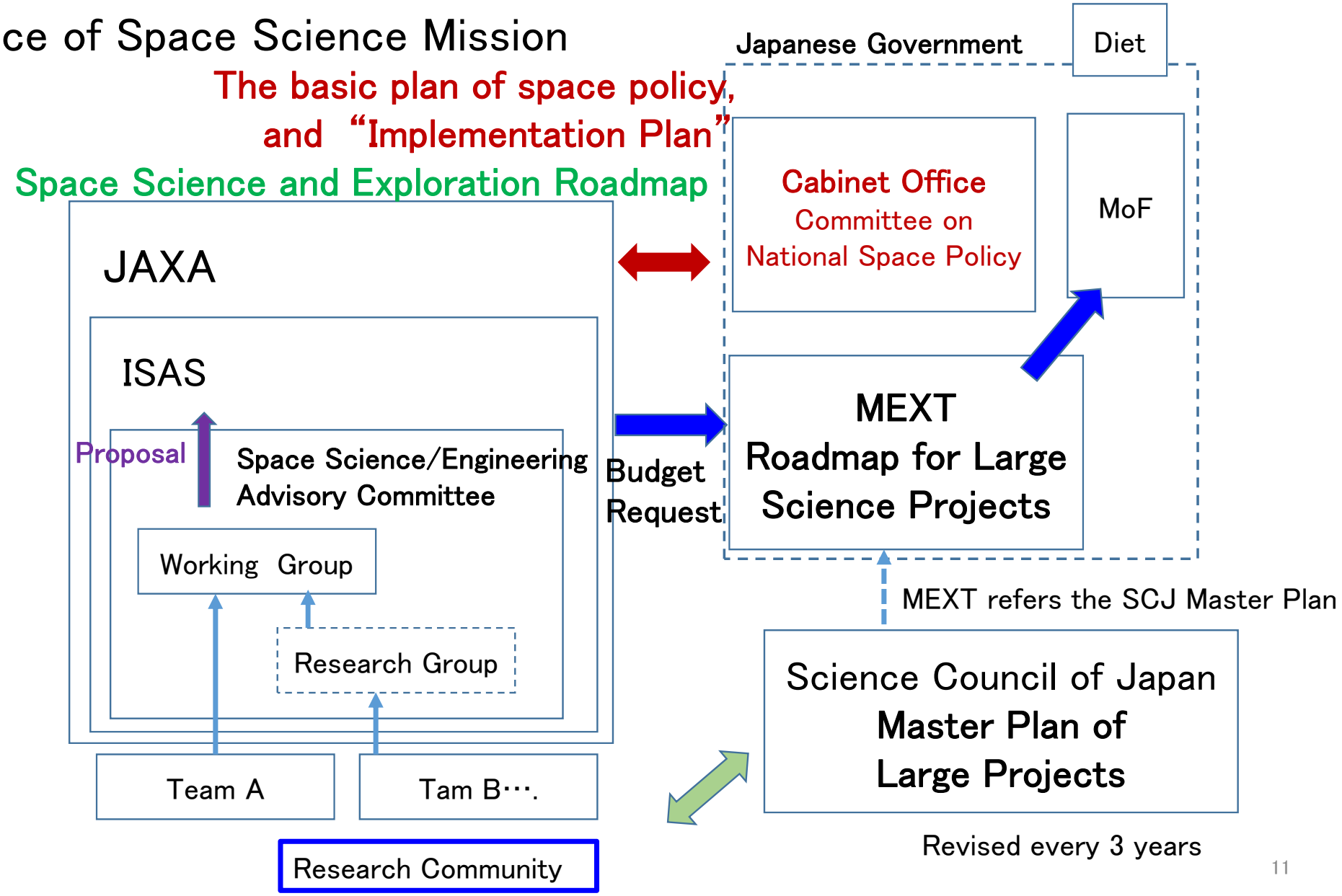
"Common Interests /
Different (Complementary) Expertise"

- Instrumentation, Basic (key) technologies
- Human resources, Facilities
- Organization

- *Japanese contribution for future "global" projects*

JAXA Science Mission Programs

Governance of Space Science Mission



JAXA Science Mission Programs in the **Space Science and Exploration Roadmap**

- **Strategic Large Class**
  < ¥30B ($300M if 1$=100¥), HIIA (H3 after 2021) launch
  ~3 missions in a decade

- **Competitive Middle Class**
  <¥5-15B ($150M), Epsilon Rocket launch
  ~5 missions in a decade

- **Strategic International Collaboration Projects**
  <¥1B($10M)/yr in total (of multiple projects)
  Small Projects
  <¥[a few]100M($[a few]M)/yr in total

Strategic L-Class Mission Candidates

To be planned

YEAR

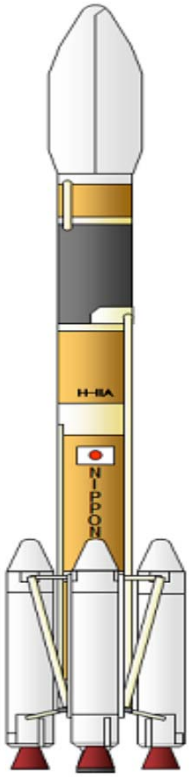
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

XRISM Project

MMX
Pre-Project

Selected
(2019 May)

Candidate (ESA CV-M5)



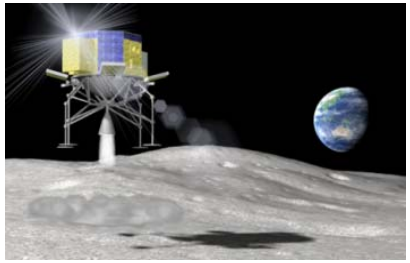
Strategic Large Missions (¥30B class) flagship science mission with HIIA/H3 vehicle

Competitive M-Class

To be planned

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

SLIM (M-1)



M-3

Small JASMINE
Selected

M-5
AO issued

M-4

DESTINY+
Pre-PhaseA(M-2)

SOLAR-C-EUVST
HiZ-GUNDAM

To be selected

Competitively-chosen medium-sized focused missions (<¥15B) with Epsilon rocket (every 2 year)

ISAS Future Missions/Mission Candidates

	Mission/Mission Concept	JAXA Status (2019 March)	Target launch
Strategic Large Class (L-Class)			
ASTRO-H successor	XRISM [X-ray Astrophysics]	Project Phase B	FY2021
L-1	Martian Moon eXploror (MMX) [Phobos sample return]	Pre-Project Phase A2	2024
L-2	LiteBIRD [CMB B-mode]	Pre-Phase A2	2027-28 TBA
(previous L-2 candidate)	OKEANOS [Solar Power Sail Trojan]	Pre-Phase A2	2027-28 TBA
L-3 candidate ESA Cosmic Vision-M5	SPICA [Infrared Astrophysics]	Pre-Phase A2 ESA Phase A (1/3 candidates)	2030 TBA
Competitive Middle Class (M-Class)			
M-1	SLIM [Moon Pin-Point Landing]	Project Phase B	FY2021 XRISM dual
M-2	Destiny+ [Phaethon Flyby]	Pre-Project Phase A1	FY2022-23 TBA
M-3	Small JASMINE [NIR Astrometry]	Pre-Phase A2	
M-4 candidate	Solar-C_EUVST [Chromosphere Solar Physics]	Pre-Phase A1b	
M-4 candidate	HiZ-GUNDAM [GRB Astrophysics]	Pre-Phase A1b	

ISAS Future Missions/Mission Candidates

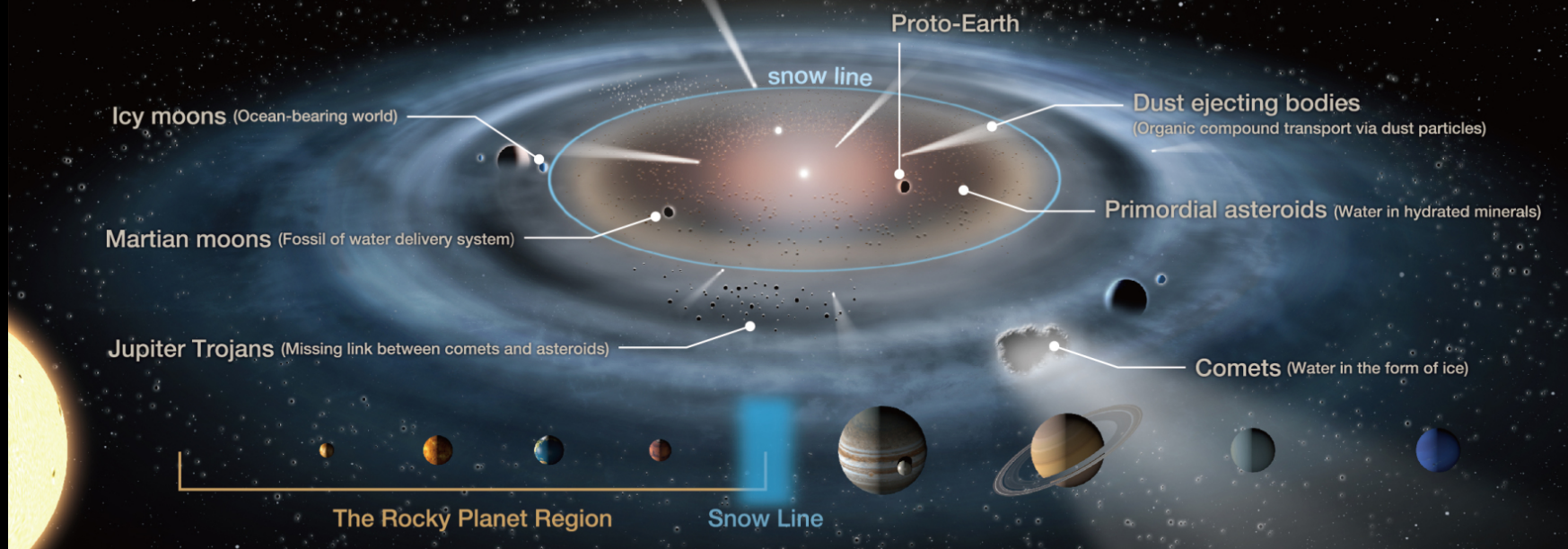
	Mission/Mission Concept	JAXA Status (2019 March)	Target launch
Small Projects [Strategic International Collaboration – Missions of Opportunities]			
ESA-Cosmic Vision-L1	JUICE [ESA Jupiter Moons]	ISAS Project Phase D	2022
NASA New Frontier 4	Dragonfly [NASA Titan]	ISAS検討（地震計を供給）	2024
ESA-Cosmic Vision-L2	Athena [X-ray Astrophysics]	Pre-Phase A1b (WG)	2031
NASA Astronomy Flagship	WFIRST [Infrared Astrophysics]	Pre-Phase A2 (ISAS team)	2025
ESA-Cosmic Vision-L3	LISA [Gravitational Wave]	Working Group	2034
Russia Spektr-UV	WSO-UV [UV / Exoplanet]	Working Group	2023 TBA

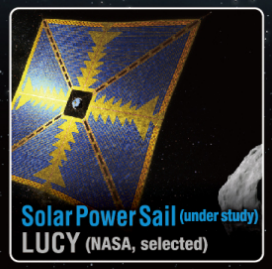
Small Projects [Small Programs] ……

ISAS Small Body Exploration Strategy

Many small bodies are born outside the snow line. These are initially comet-like but can evolve to show a variety of faces.
By delivering water and organic compounds, these small bodies may have enabled the habitability of our planet.

When, who and how?





The fleet of ISAS small body missions explores these questions

Future Science Missions in **Astrophysics** and JAXA Programs

Big Questions in Astrophysics

Origins of the Space and Time of the Universe

Beyond the Big Bang Theory
-Cosmic Inflation?
-Dark Energy/ Modified Gravity

Structure Formation and Evolution

-Dark Matter
-First Stars/First Galaxies/First SMBHs
-Chemical Enrichment /
Evolution of Solid / Organic
-Planetary Formation

Possibility of Life in the Universe

- Characterization of Planetary Atmosphere and Surfaces
- Bio Signature

Fundamental Physics

- Quantum Entanglement
- Equivalence Principle

Future Astrophysics Missions

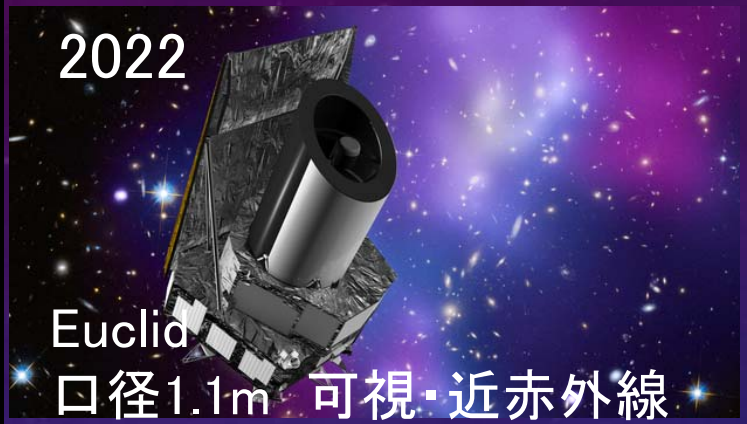
Agency/ Nation	“FLAGSHIP” (>$1B)	Middle/Large (~$250M-1000M)	Small/Middle
NASA	JWST/ WFIRST	SPHEREx	TESS (2018) IXPE
ESA	LISA / Athena	Euclid / PLATO / ARIEL M5(SPICA/THESEUS/ENVISION)	CHEOPS(2019)
China		DAMPE(2015),HXMT (2016) SST-Surveyor	QUESS(2016), Einstein Probe
India			ASTROSAT (2015)
Russia		Spektr-RG(EROSITA) (2019) Spektr-UV(WSO-UV)	
Japan		XRISM LiteBIRD / SPICA	Small-JASMINE M4(Solar-C/HiZ-GUNDAM)

Landscape in 2020's　Large Space Missions

2021

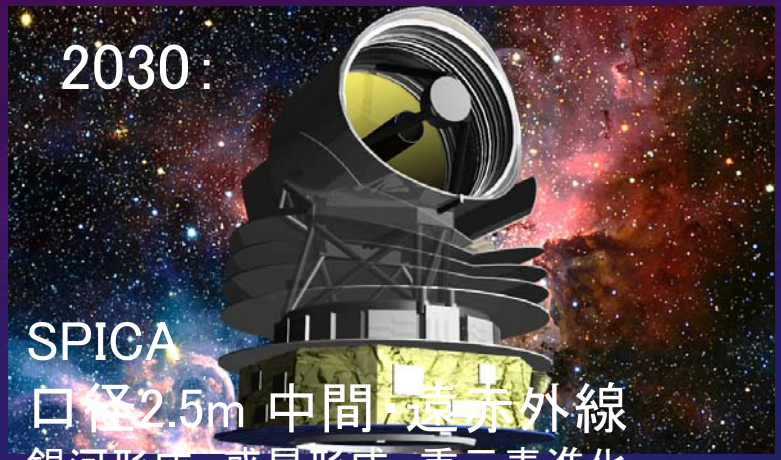
JWST
口径6.5m　近赤外線

2022



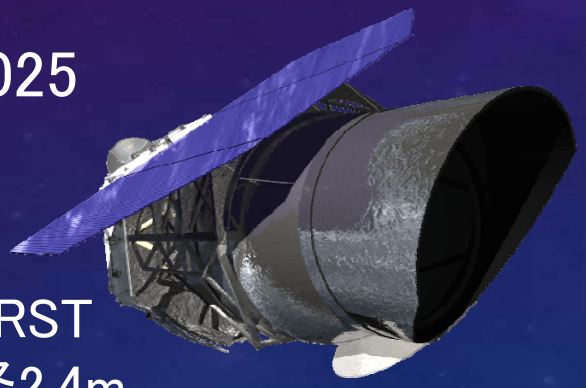
Euclid
口径1.1m　可視・近赤外線
広視野サーベイ(暗黒エネルギー)

2030：



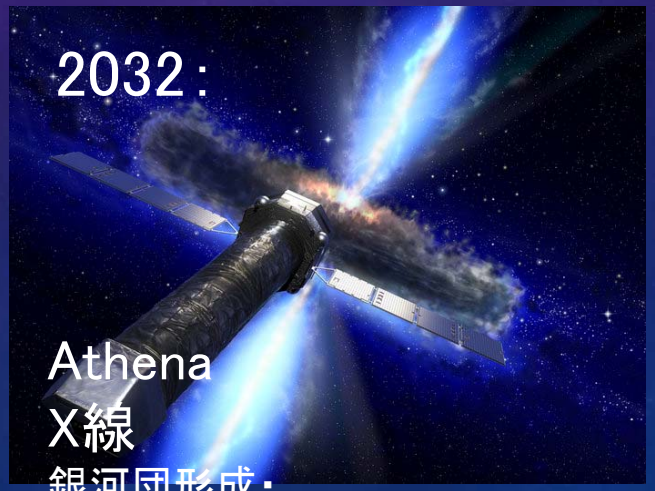
SPICA
口径2.5m 中間・遠赤外線
銀河形成、惑星形成、重元素進化

2025



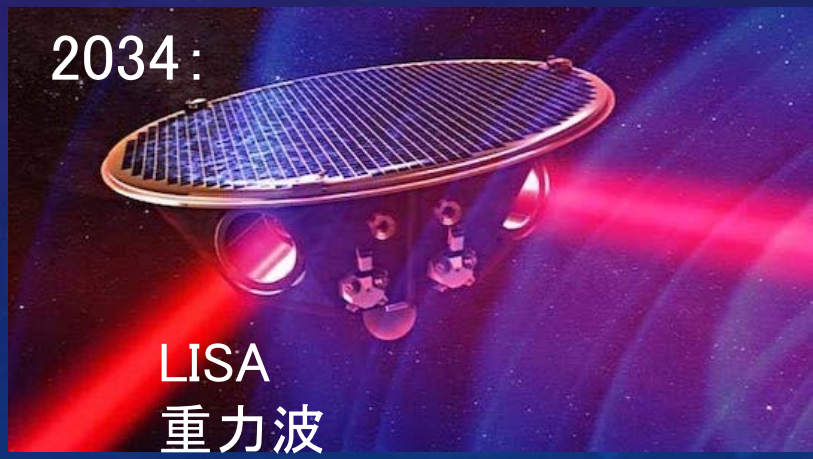
WFIRST
口径2.4m
広視野近赤外線
系外惑星・宇宙論

2032：



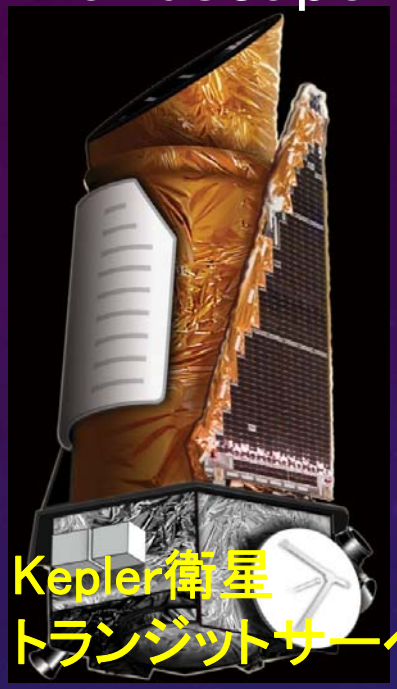
Athena
X線
銀河団形成・
宇宙初期巨大ブラックホール

2034：

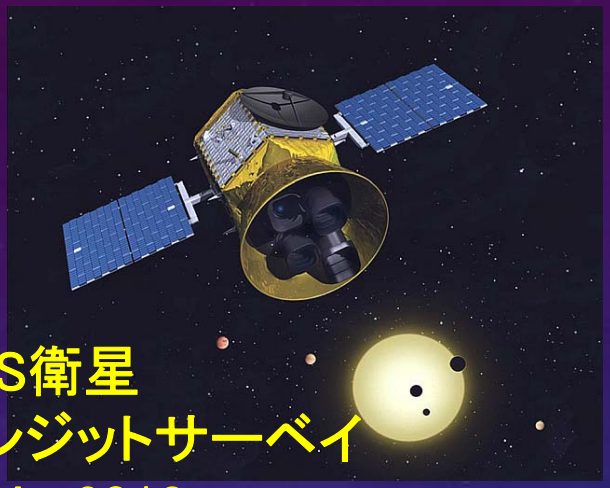


LISA
重力波
巨大ブラックホール形成・
中性子星合体

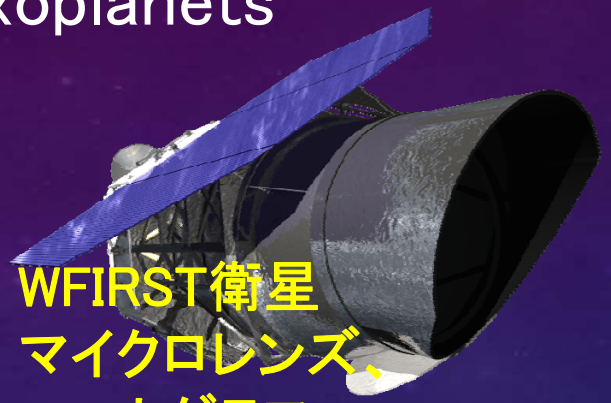
Landscape in 2020's Space Missions for Exoplanets



Kepler衛星
トランジットサーベイ
NASA　2006

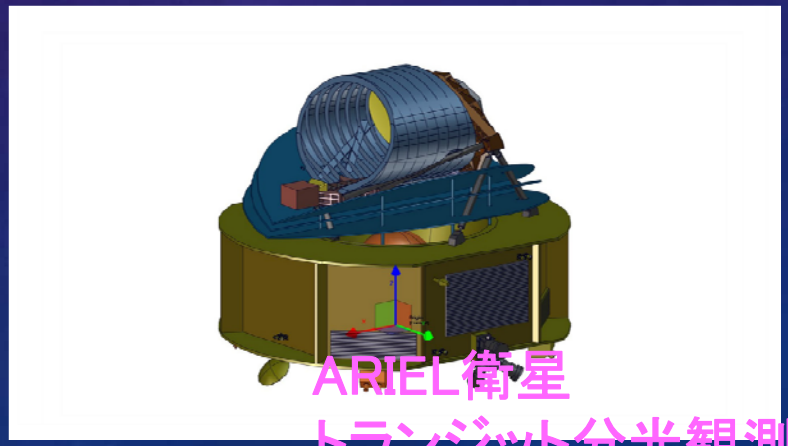


TESS衛星
トランジットサーベイ
NASA　2018



WFIRST衛星
マイクロレンズ、
コロナグラフ
NASA　2025~

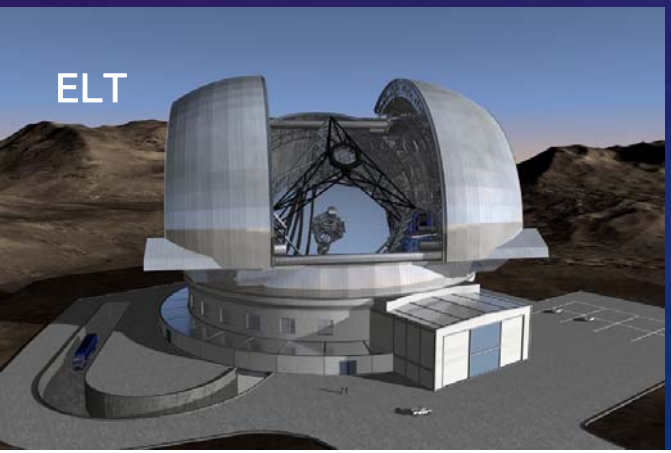
PLATO衛星
トランジットサーベイ
ESA　2024~



ARIEL衛星
トランジット分光観測
ESA　2028~

CHEOPS(小型)衛星
トランジット観測
ESA　2019~

地上の大型計画・将来計画

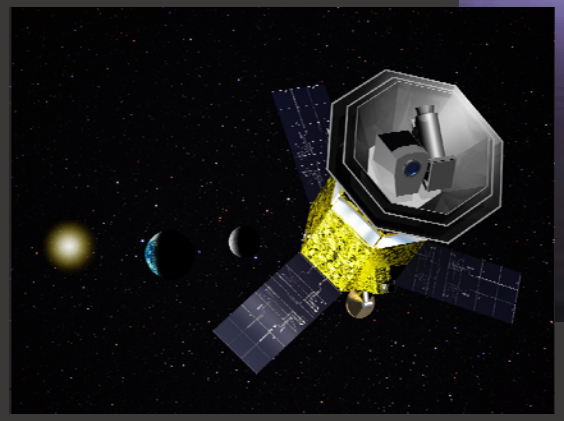


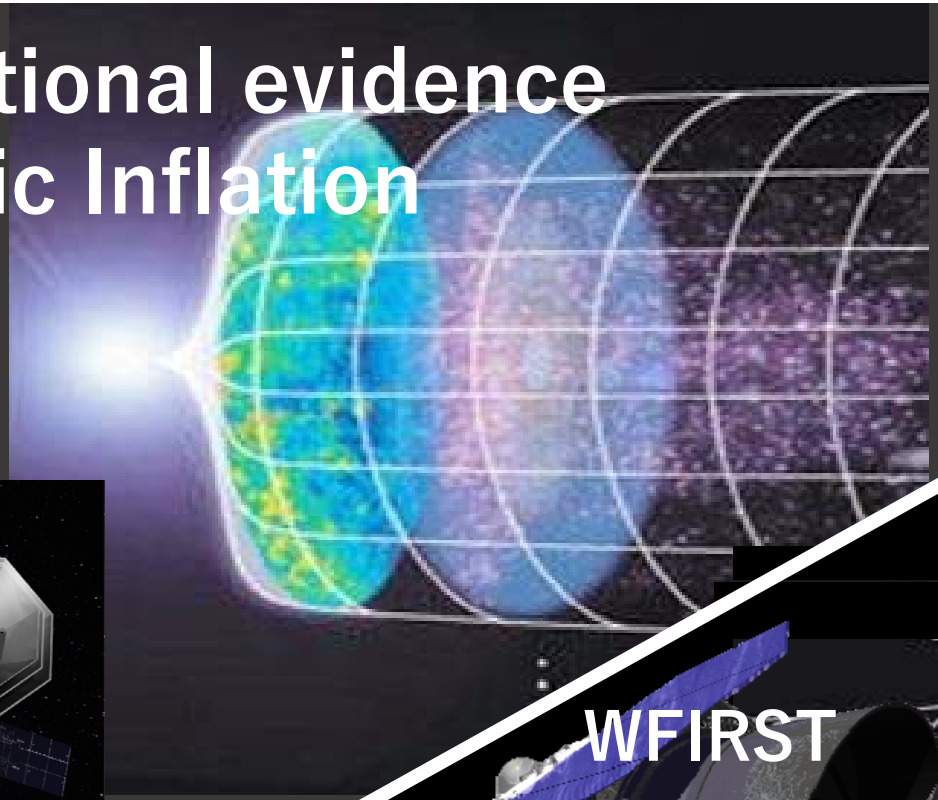
Big Questions in Astrophysics

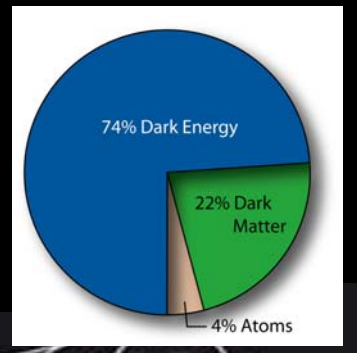
- Origins of the Space and Time of the Universe
  - Beyond the Big Bang Theory
  - **-Cosmic Inflation? ← LiteBIRD**
  - **-Dark Energy/ Modified Gravity ← WFIRST contribution**
- Structure Formation and Evolution
  - -Dark Matter
  - -First Stars/First Galaxies/First SMBHs
  - -Chemical Enrichment / Evolution of Solid / Organic
  - -Planetary Formation
- Possibility of Life in the Universe

Observational evidence of Cosmic Inflation

LiteBIRD







WFIRST

Toward understanding the nature of Dark Energy

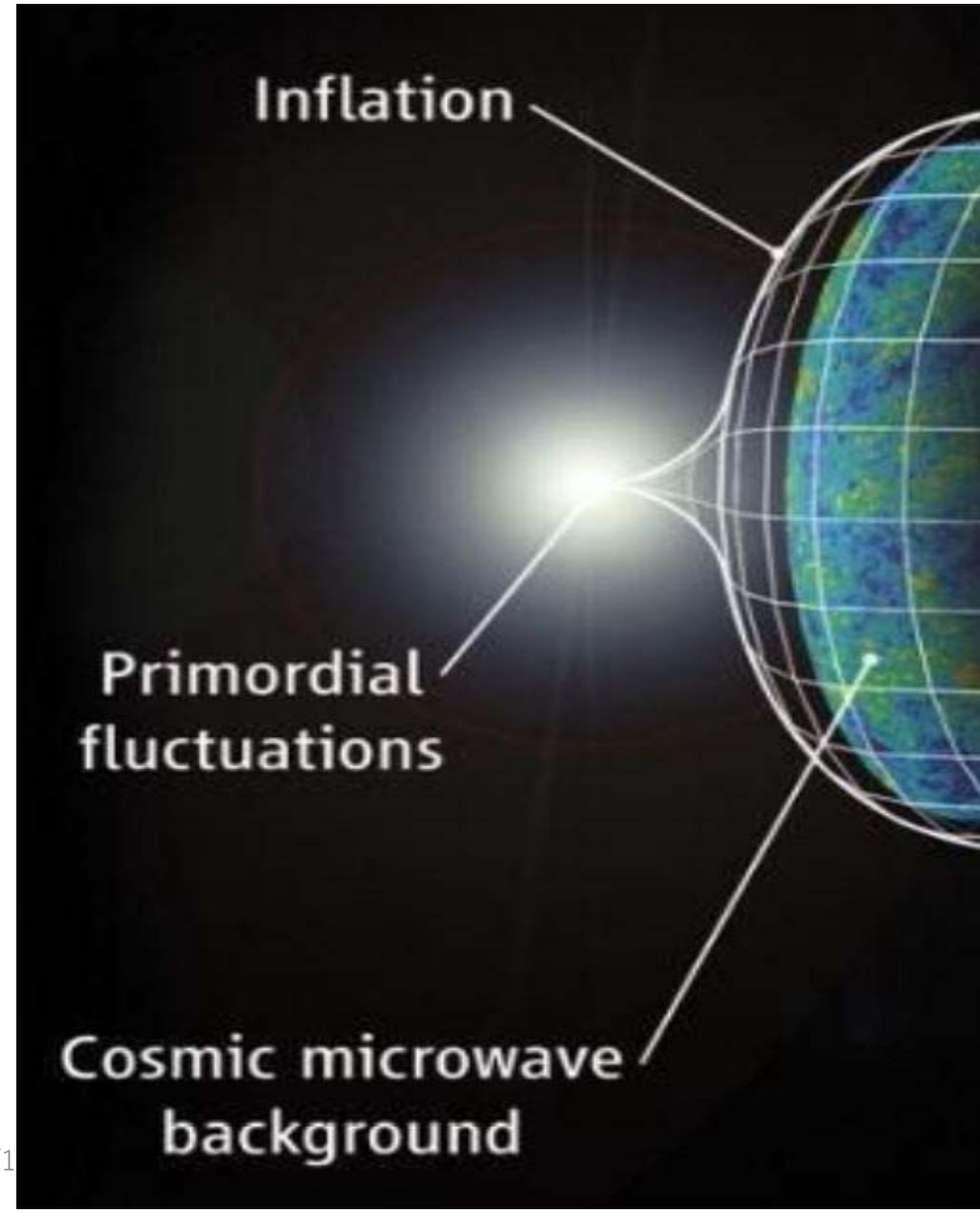
Cosmic Inflation?

Solving the horizon problem, and the flatness problems

Re-heating the Universe to Big Bang

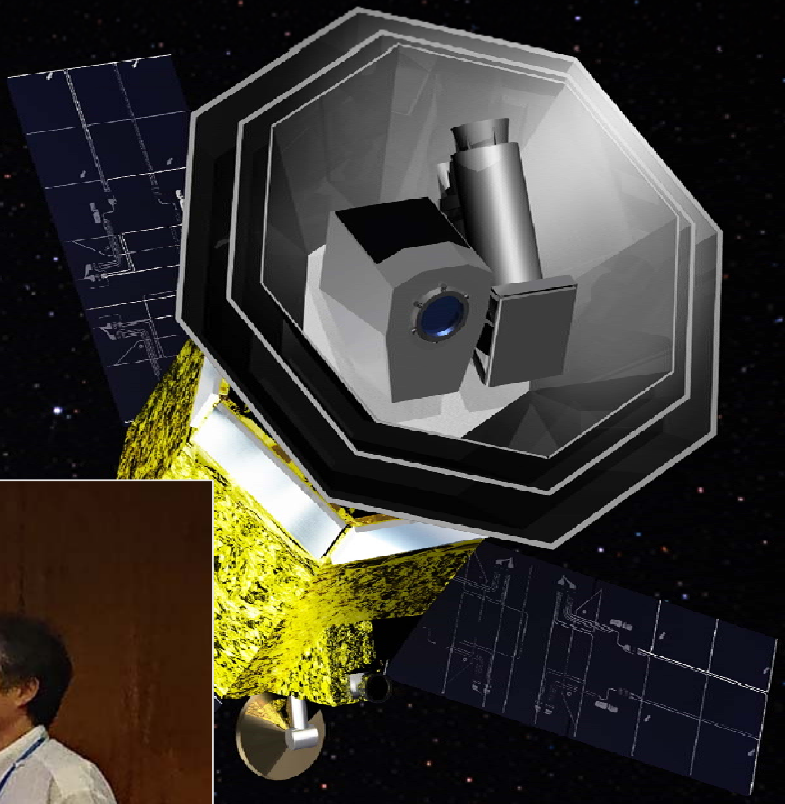
Quantum fluctuation
➔ Origins of the structure in the universe

Observational evidence?



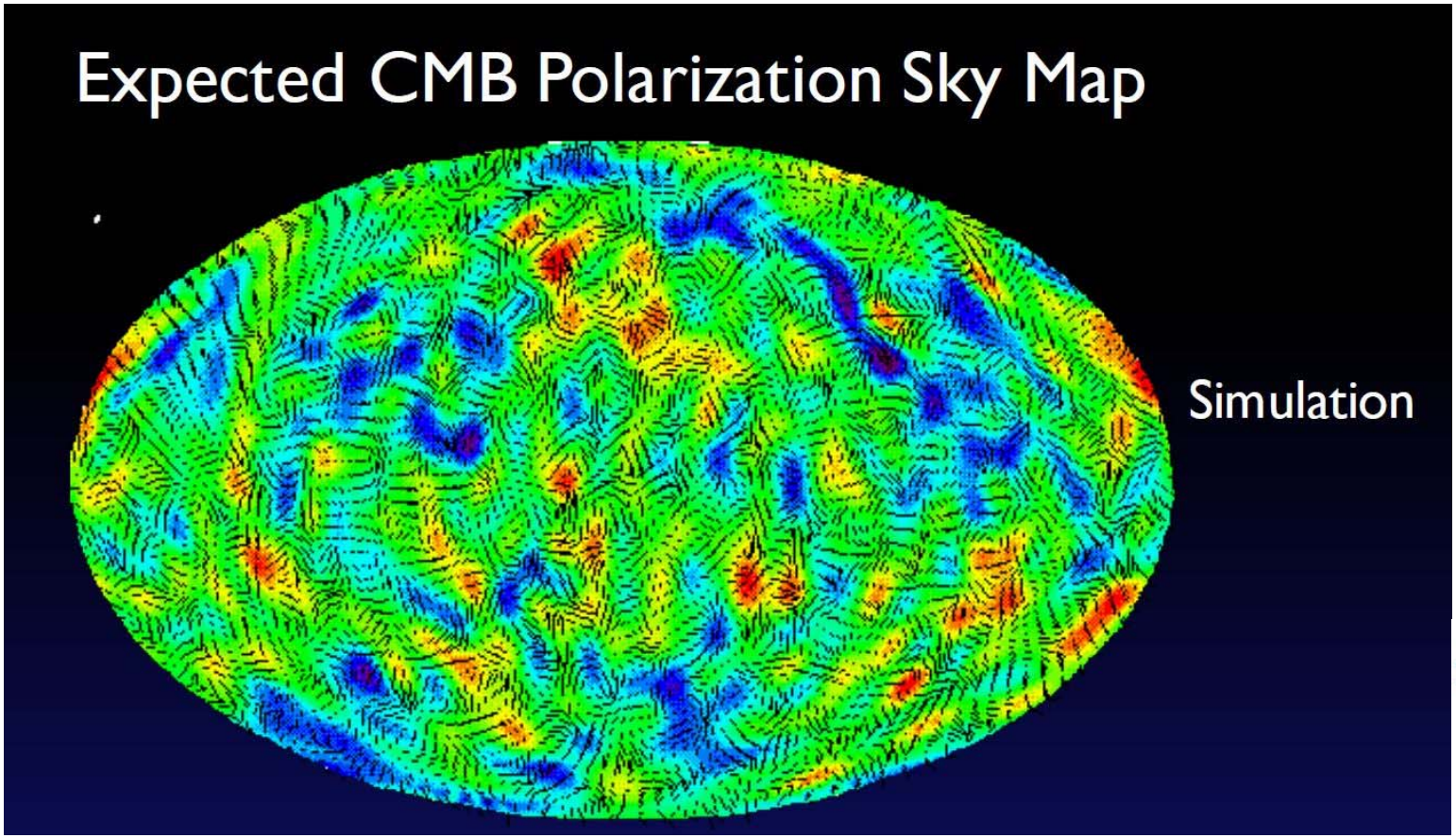
LiteBIRD

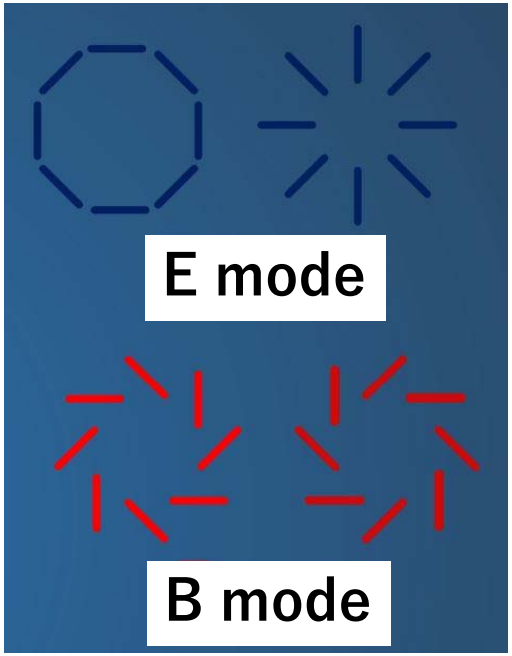
Official announcement
http://www.isas.jaxa.jp/home/rikou/godo/2019/0602/gbi7uzhxfxmz/misison_selection_announcement_may2019.pdf

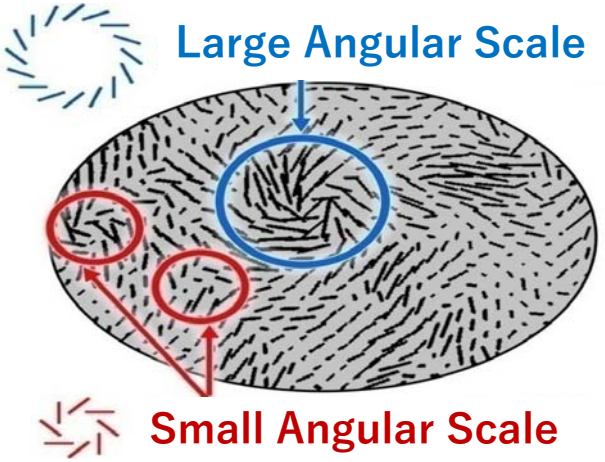


Kick-off International Symposium
July 1-2 @ ISAS

Selectedfor L-2


Expected CMB Polarization Sky Map
Simulation


E mode
B mode


Large Angular Scale
Small Angular Scale

Big Questions Left in Astrophysics

- Origins of the Space and Time of the Universe
  - Beyond the Big Bang Theory
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  - -Dark Energy/ Modified Gravity
- **Structure Formation and Evolution**
  - -Dark Matter
  - -First Stars/First Galaxies/First SMBHs
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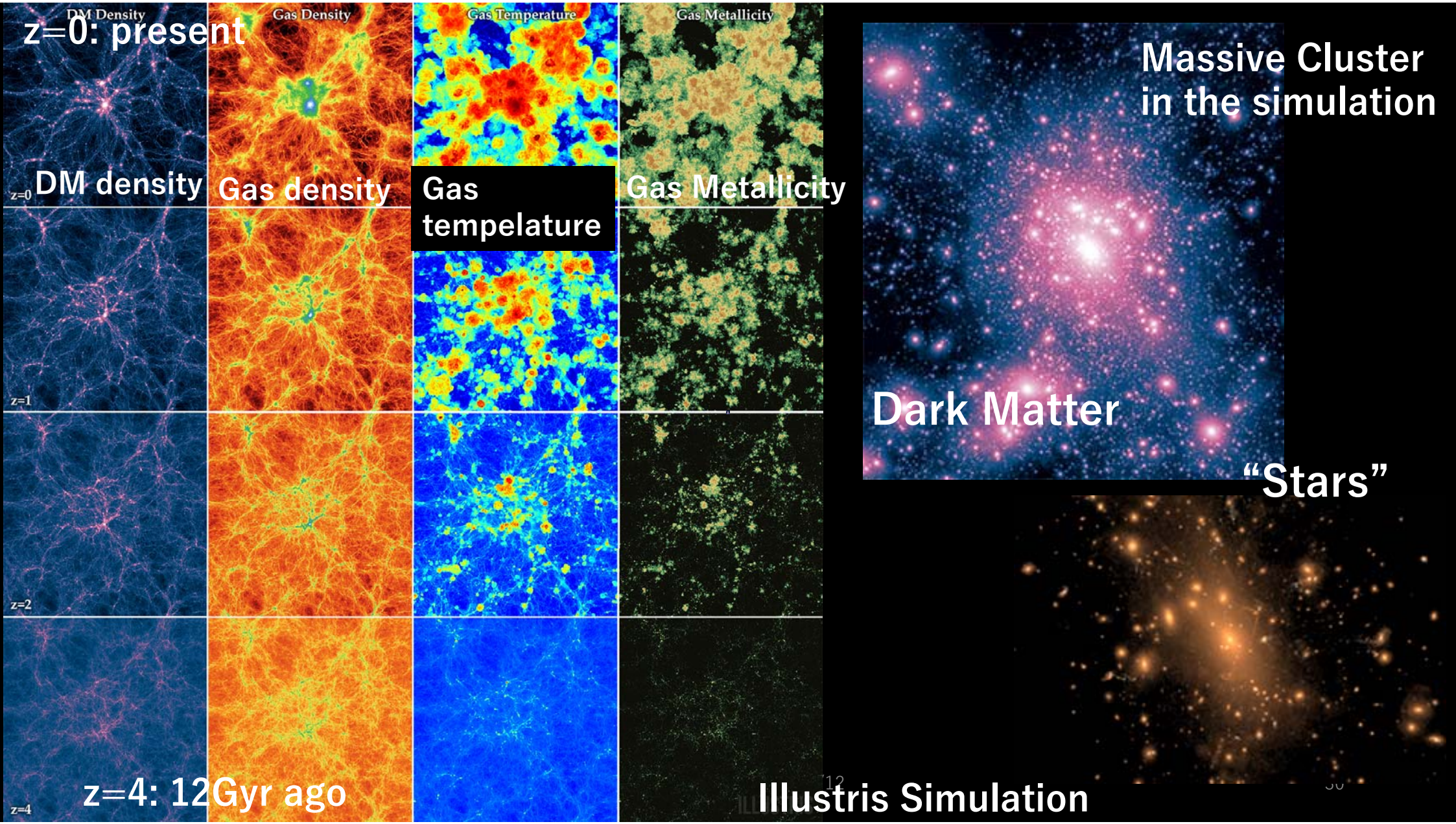
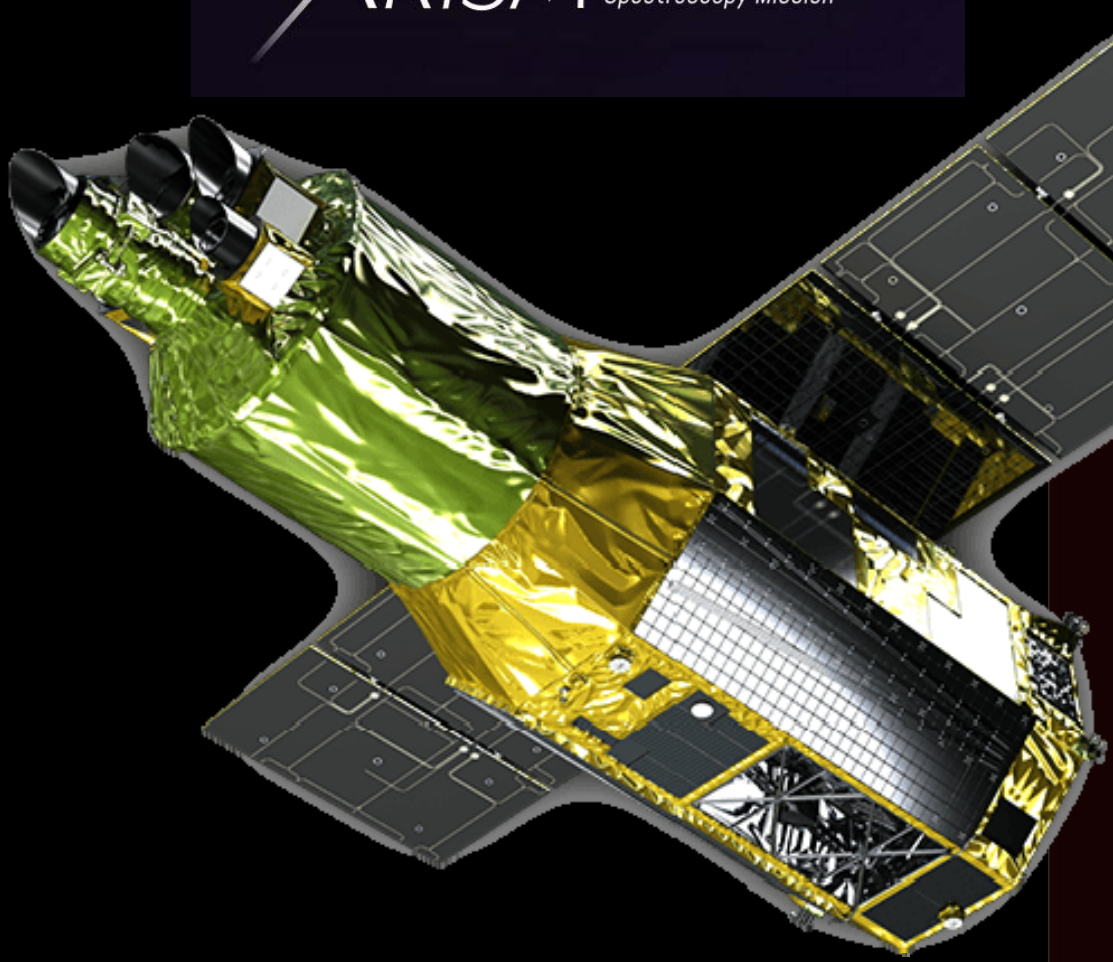
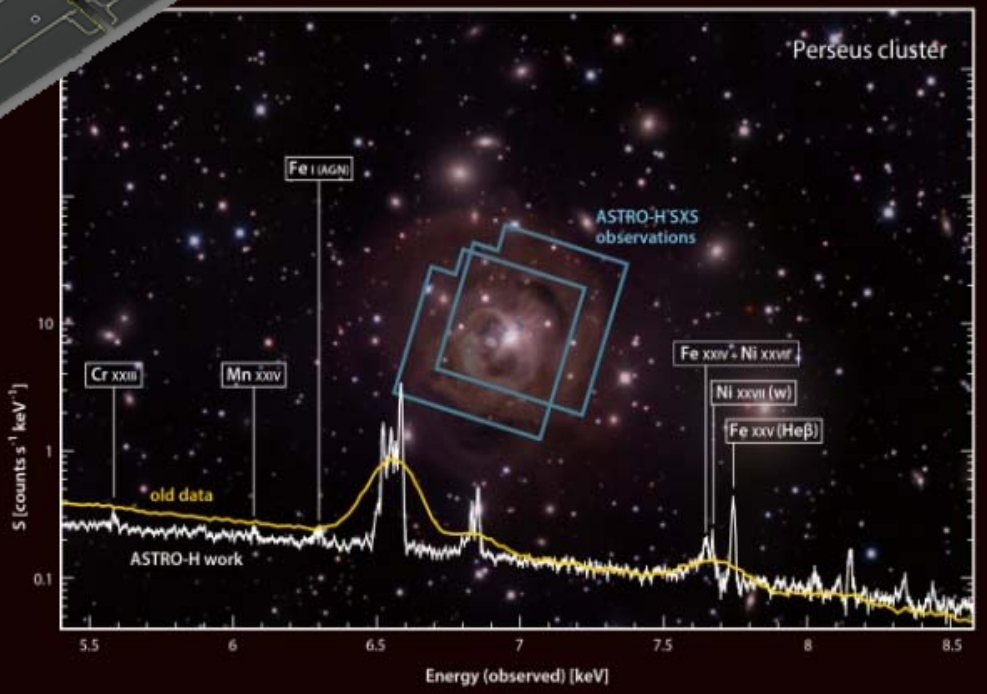
  - -Planetary Formation
- Possibility of Life in the Universe


DM Density
Gas Density
Gas Temperature
Gas Metallicity
z=0: present
DM density
Gas density
Gas tempelature
Gas Metallicity
z=0
z=1
z=2
z=4
z=4: 12Gyr ago
Massive Cluster in the simulation
Dark Matter
“Stars”
Illustris Simulation

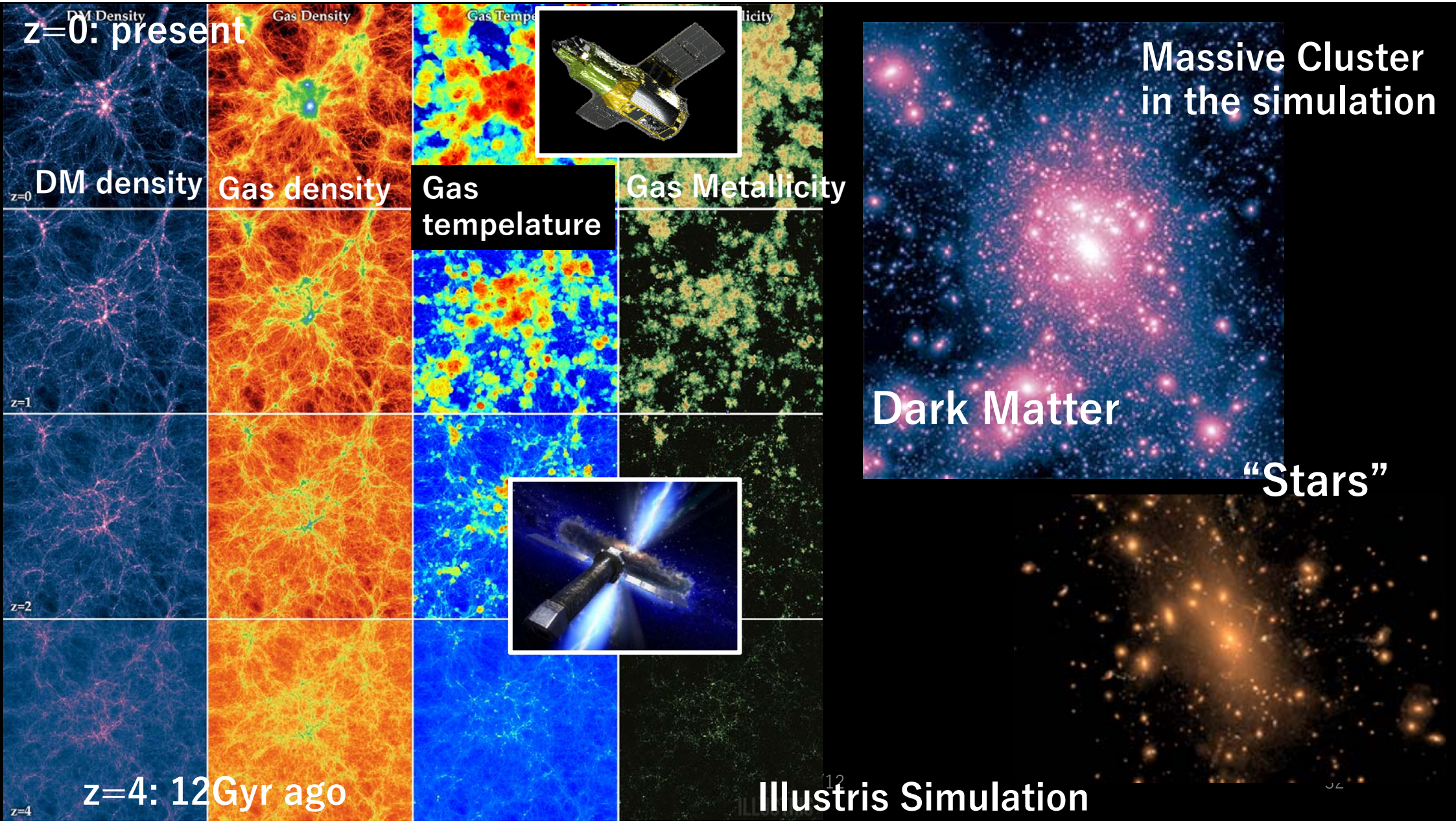
XRISM

X-Ray Imaging and Spectroscopy Mission





Credit: JAXA/Ken Crawford (Rancho Del Sol Observatory)

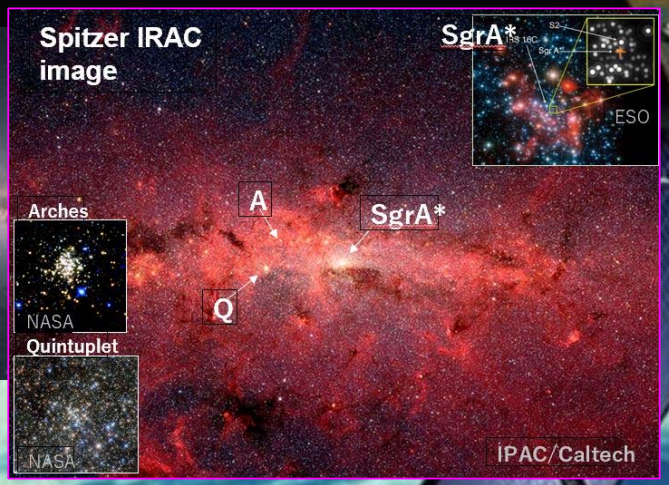

z=0: present
DM density
Gas density
Gas tempelature
Gas Metallicity
z=0
z=1
z=2
z=4
z=4: 12Gyr ago
Massive Cluster
in the simulation
Dark Matter
“Stars”
Illustris Simulation

Small–JASMINE

National Astronomical Observatory of Japan
JASMINE Project Office

M-Class
Selected for M-3

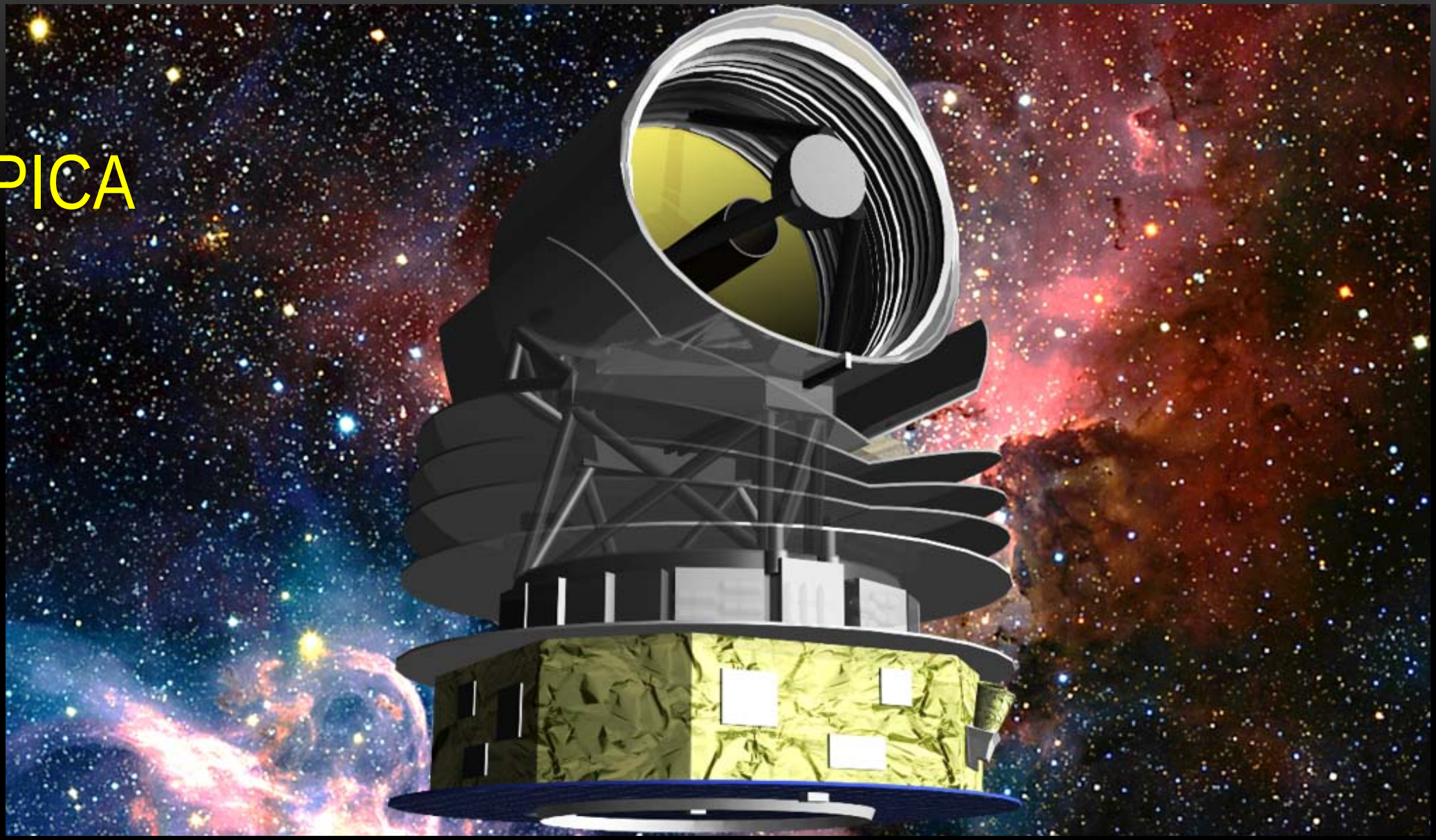
NIR Astrometry
Inner bulge region of Milky Way

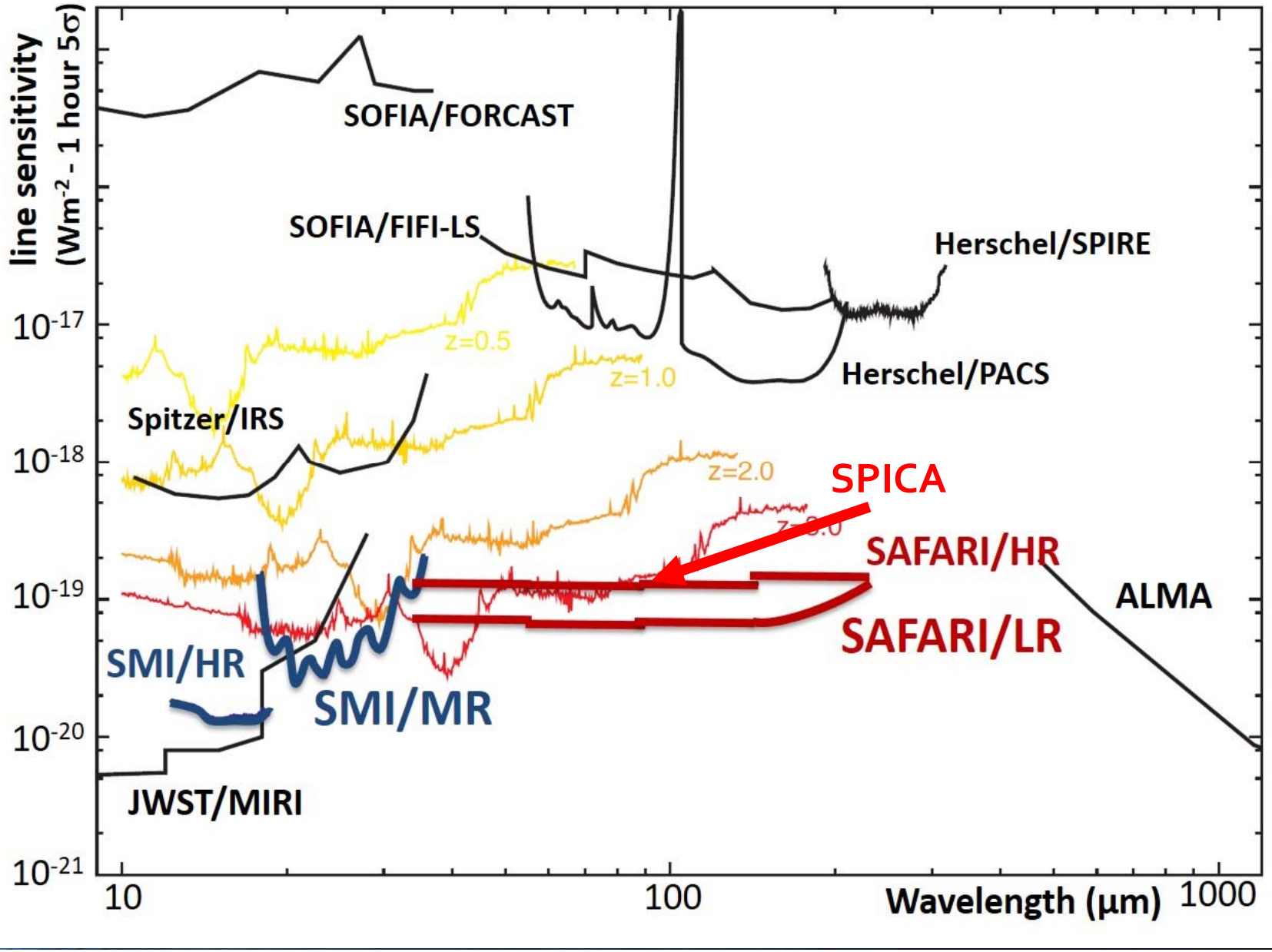


Big Questions Left in Astrophysics

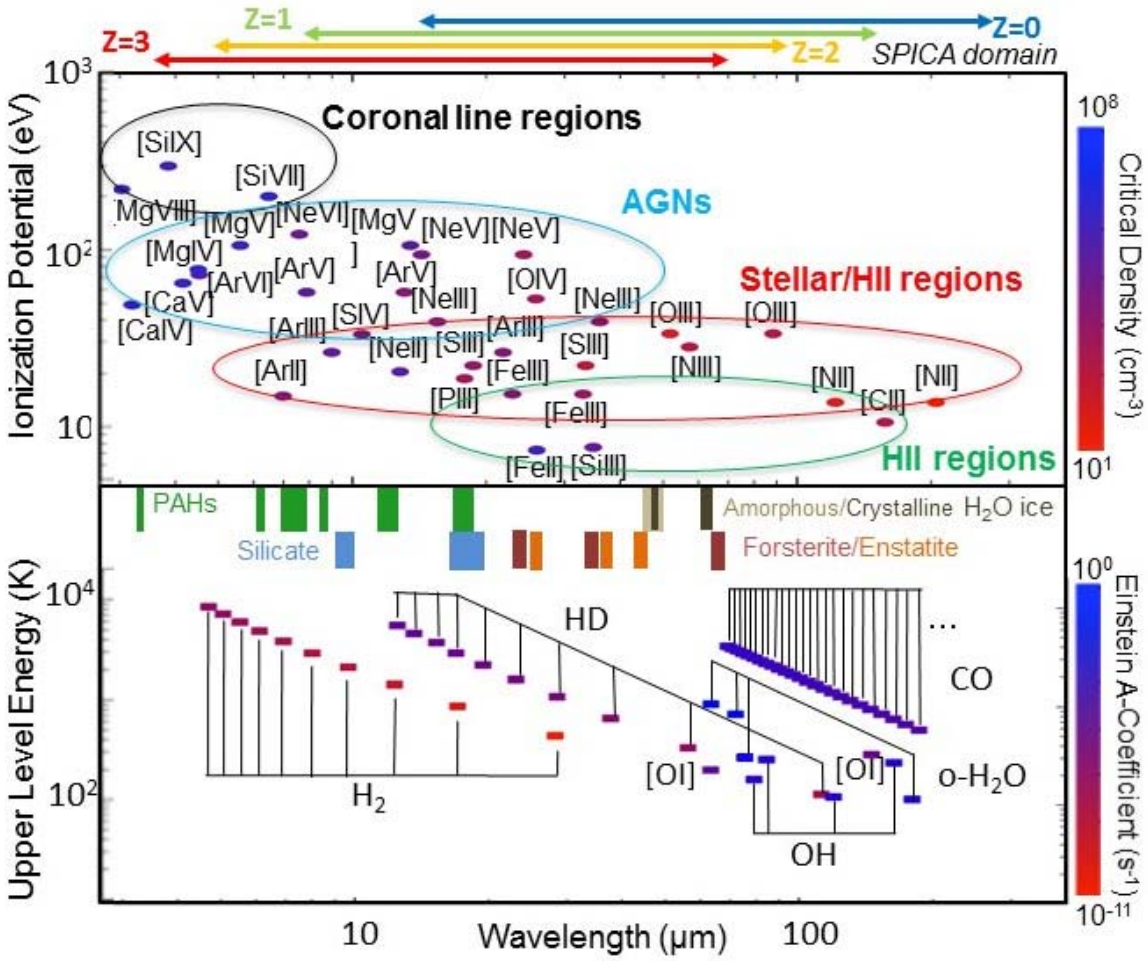
- Origins of the Space and Time of the Universe
  - Beyond the Big Bang Theory
  - -Cosmic Inflation?
  - -Dark Energy/ Modified Gravity
- **Structure Formation and Evolution**
  - -Dark Matter
  - -First Stars/First Galaxies/First SMBHs
  - **-Chemical Enrichment / Evolution of Solid / Organic**
  - **-Planetary Formation**
- **Possibility of Life in the Universe**

SPICA

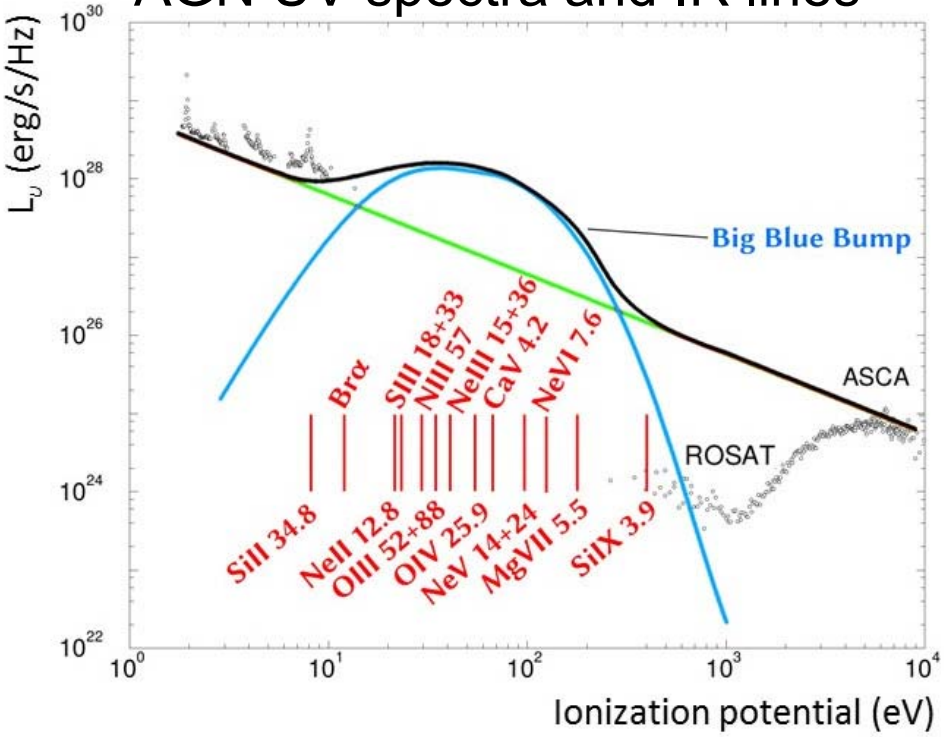



line sensitivity
(Wm-2 - 1 hour 5σ)
SOFIA/FORCAST
SOFIA/FIFI-LS
Herschel/SPIRE
Herschel/PACS
z=0.5
z=1.0
z=2.0
Spitzer/IRS
SPICA
SAFARI/HR
SAFARI/LR
ALMA
SMI/HR
SMI/MR
JWST/MIRI
10-17
10-18
10-19
10-20
10-21
10
100
1000
Wavelength (μm)

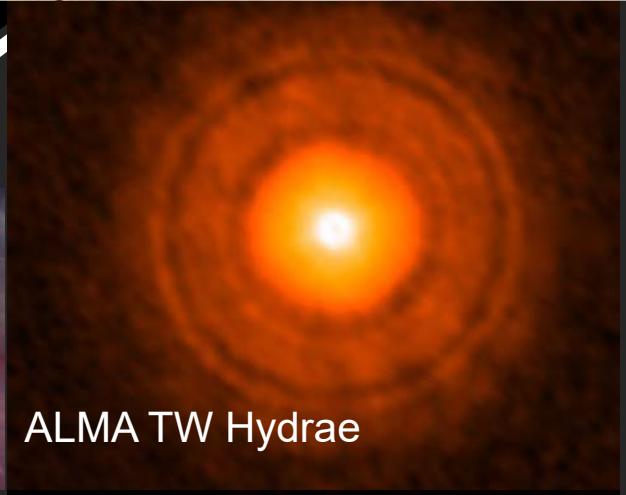
Rich Infrared Probes



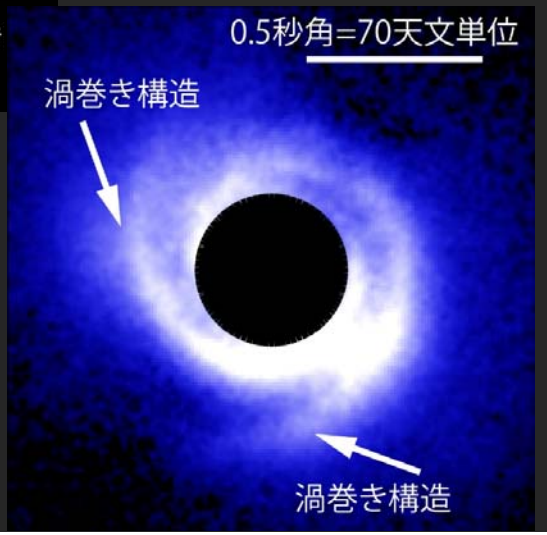
AGN UV spectra and IR lines

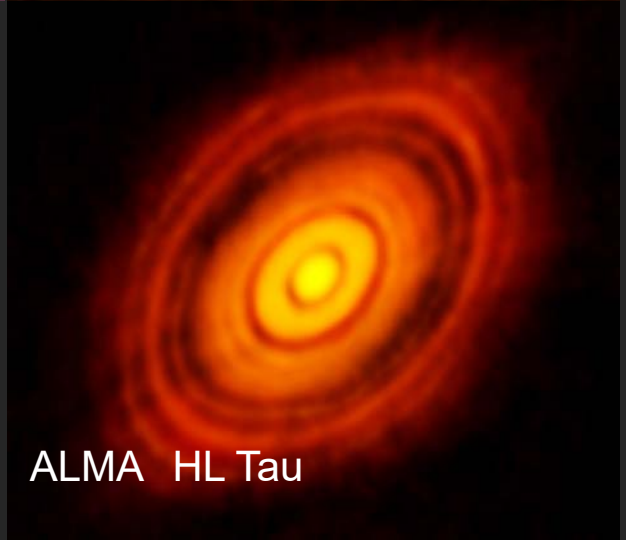


Planetary Formation

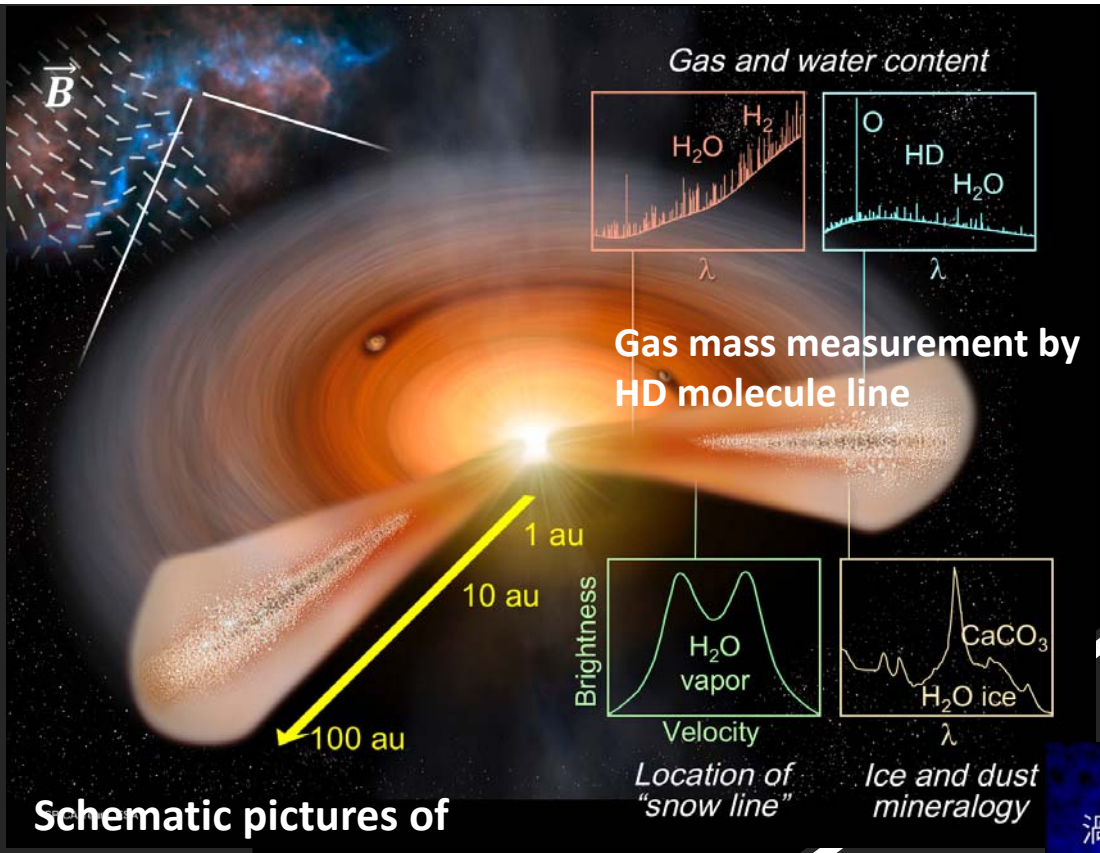


ALMA TW Hydrae

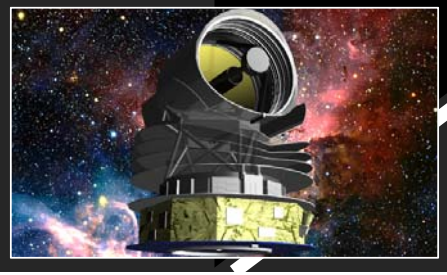




ALMA HL Tau



Schematic pictures of SPICA proto-planetary disk study



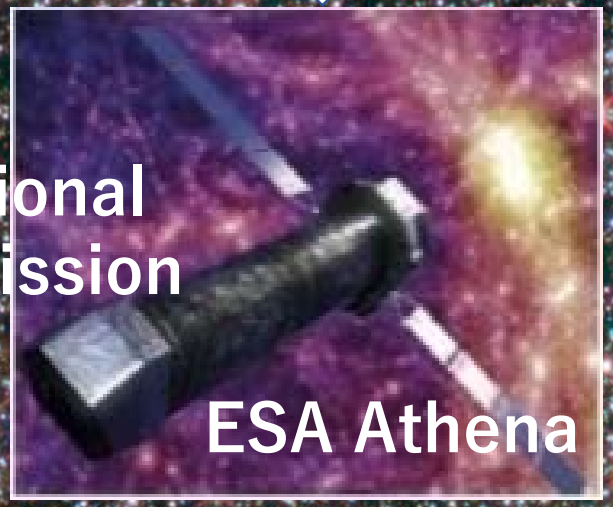
SPICA Space Infrared Telescope for Cosmology and Astrophysics

- 2.5 m telescope, which is cryogenically cooled down to below 8 K
- Spectroscopy at mid/far infrared ar 12-350 μm
  Instruments: SMI(mid-infrared), SAFARI (far-infrared),
  B-BOP(infrared polarimetric imaging)
- Joint space mission of Europe and Japan,
  to be launched at ~2030
- **ESA: Cosmic Vision M-5 : One of the THREE (of 25) candidates**
  Final Selection 2021 June / Adoption 2024
  JAXA: Prioritized candidate (not adopted) for L-3

Cryogenic Payload Missions

Cryogenic Detector Systems

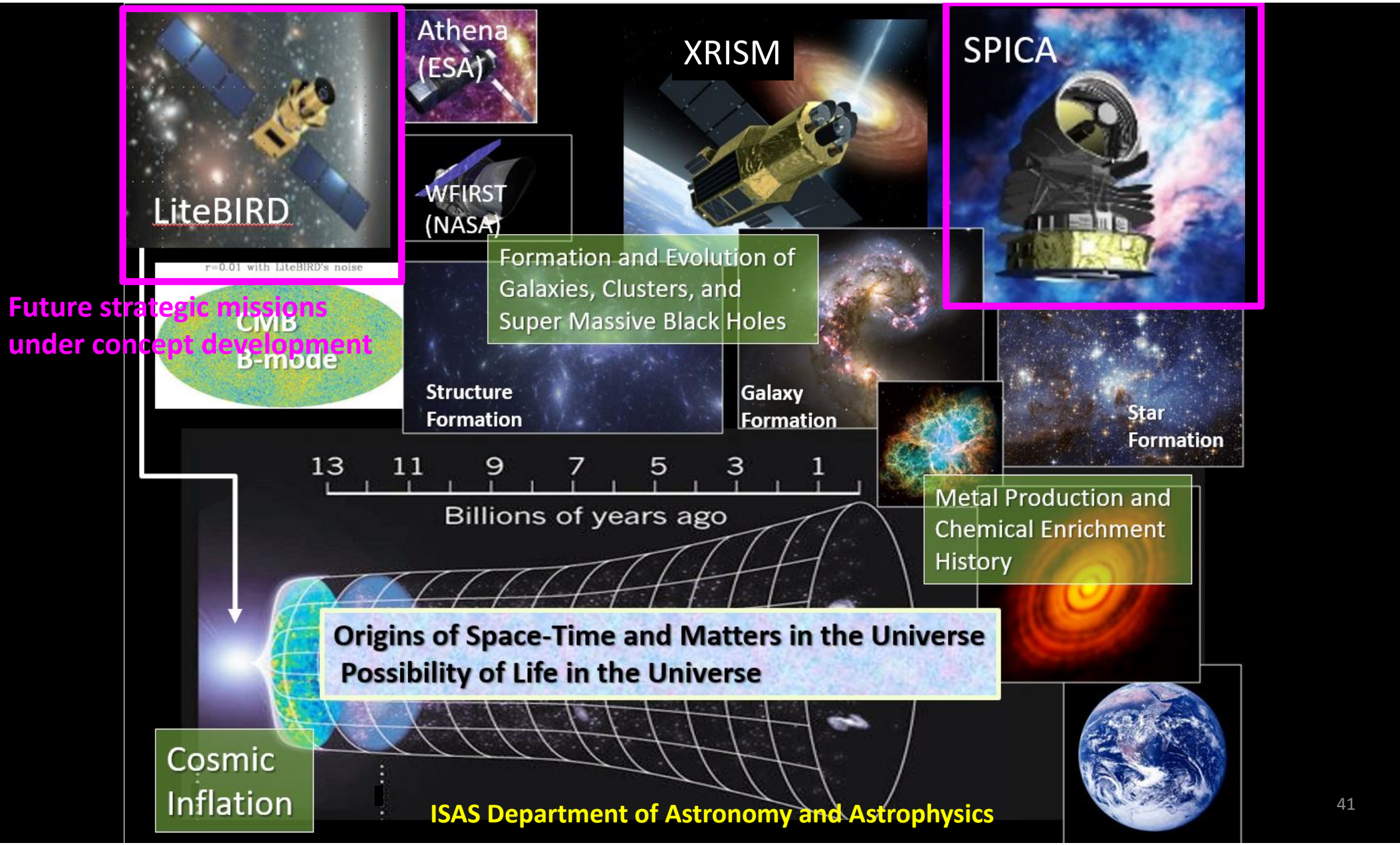
JAXA-led mission



International Large mission

JAXA “Key technology” for development

“JAXA Space Science Technology Roadmap”


LiteBIRD
Athena (ESA)
XRISM
SPICA
WFIRST (NASA)
Future strategic missions under concept development
r=0.01 with LiteBIRD's noise
CMB B-mode
Formation and Evolution of Galaxies, Clusters, and Super Massive Black Holes
Structure Formation
Galaxy Formation
Star Formation
13 11 9 7 5 3 1
Billions of years ago
Metal Production and Chemical Enrichment History
Origins of Space-Time and Matters in the Universe
Possibility of Life in the Universe
Cosmic Inflation
ISAS Department of Astronomy and Astrophysics

世界の計画 (1)

残された課題	JAXA の取組み	JAXAの国際協力による取組み	海外の取組み
①　宇宙の空間／時間構造とその起源			
宇宙背景放射による原始重力波痕跡の検出による宇宙初期インフレーション検証	LiteBIRD [➔PhaseA1]		
原始重力波の直接検出	将来計画検討 (DECIGOなど)		(LISA)
暗黒エネルギーの性質への手がかり		WFIRST協力 [Pre-Phase A2]	Euclid [2021] WFIRST[2025]
②　宇宙における構造の発展と天体の形成			
②-A 宇宙における構造形成史(全体)における未解決問題			
宇宙の暗黒物質の分布、正体の解明		WFIRST協力 GAPS［気球：小規模］	Euclid WFIRST
宇宙の初代銀河・初代星の全般的な理解 宇宙再電離前後の天体形成	HiZ-GUNDAM [Pre-Phase A1b]	WFIRST協力	JWST [2020] Euclid WFIRST Theseus [Phase0/A] LUVOIR/Lynx [STDT]

世界の計画 (2)

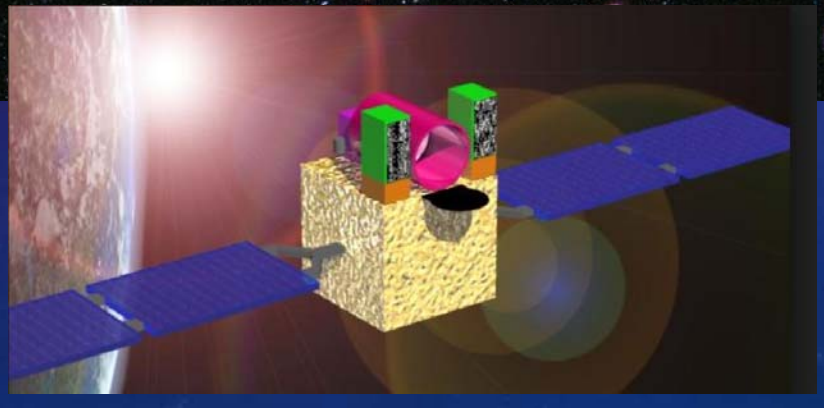
残された課題	JAXA の取組み	JAXAの国際協力による取組み	海外の取組み
②-B 宇宙の構造形成におけるバリオン物理過程の解明			
銀河内部構造の形成		WFIRST協力	JWST [2020] WFIRST[2025] LUVOIR [STDT]
ダストに隠された銀河形成初期の星形成と巨大ブラックホールの形成	SPICA [Pre-PhaseA2] FORCE [Pre-Phase A1]	Athena [Pre-Phase A1]	JWST Athena [PhaseA] SPICA[Phase0/A] OST/Lynx [STDT]
銀河団におけるガスの運動と力学的構造	XRISM [FY2021]	Athena	Athena
中高温銀河間ガスの直接検出	XRISM 将来計画	Athena	Athena LUVOIR/Lynx[STDT]
銀河団高温ガスの熱的・化学的進化	XRISM	Athena	Athena , Lynx [STDT]
②-C 宇宙の重元素およびダストの生成・化学進化			
超新星爆発・中性子合体における重元素生成	XRISM	Athena [Pre-Phase A1]	Athena , Lynx [STDT] LISA [PhaseA]
銀河形成期の化学進化過程	SPICA		JWST SPICA, OST [STDT]
宇宙におけるダストの生成と俯瞰的進化	SPICA		SPICA OST [STDT]

世界の計画 (3)

残された課題	JAXA の取組み	JAXAの国際協力による取組み	海外の取組み
②-D 星形成・ブラックホール現象の物理			
ブラックホール直近の時空構造	XRISM [2021]	Athena [Pre-Phase A1b]	Athena [PhaseA]
星形成に至るガスの収縮・分裂過程	SPICA [Pre-PhaseA2]		SPICA[Phase0/A], OST [STDT]
②-E 惑星系形成			
原始惑星系円盤におけるガスの散逸と巨大ガス惑星生成	SPICA		SPICA OST [STDT]
原始惑星系円盤：H_2O の気体・固体分布	SPICA		SPICA OST [STDT]
③ 太陽系外惑星の検出および大気詳細研究			
太陽系外惑星の質量・軌道分布の全体像		WFIRST協力 [Pre-Phase A2]	WFIRST[2025]
太陽系近傍・明るい恒星での系外惑星探査			TESS [2018], PLATO [2026]
太陽系外惑星の大気スペクトル観測（トランジット観測）			JWST [2020], ARIEL [2028] OST/HabEx[STDT]
太陽系外惑星の大気スペクトル観測（直接観測）		WFIRST協力 WSO 協力 [Pre-Phase A1a]	WFIRST, WSO [2023:]
ハビタブル地球型惑星の大気・生命兆候			LUVOIR/HabEX [STDT]

First Objects
Multi-Messenger Science
(GRB at z>6/short GRB)

HiZ-GUNDAM



Infrared Astrometry
Of the Bulge of Milky Way

Small JASMINE

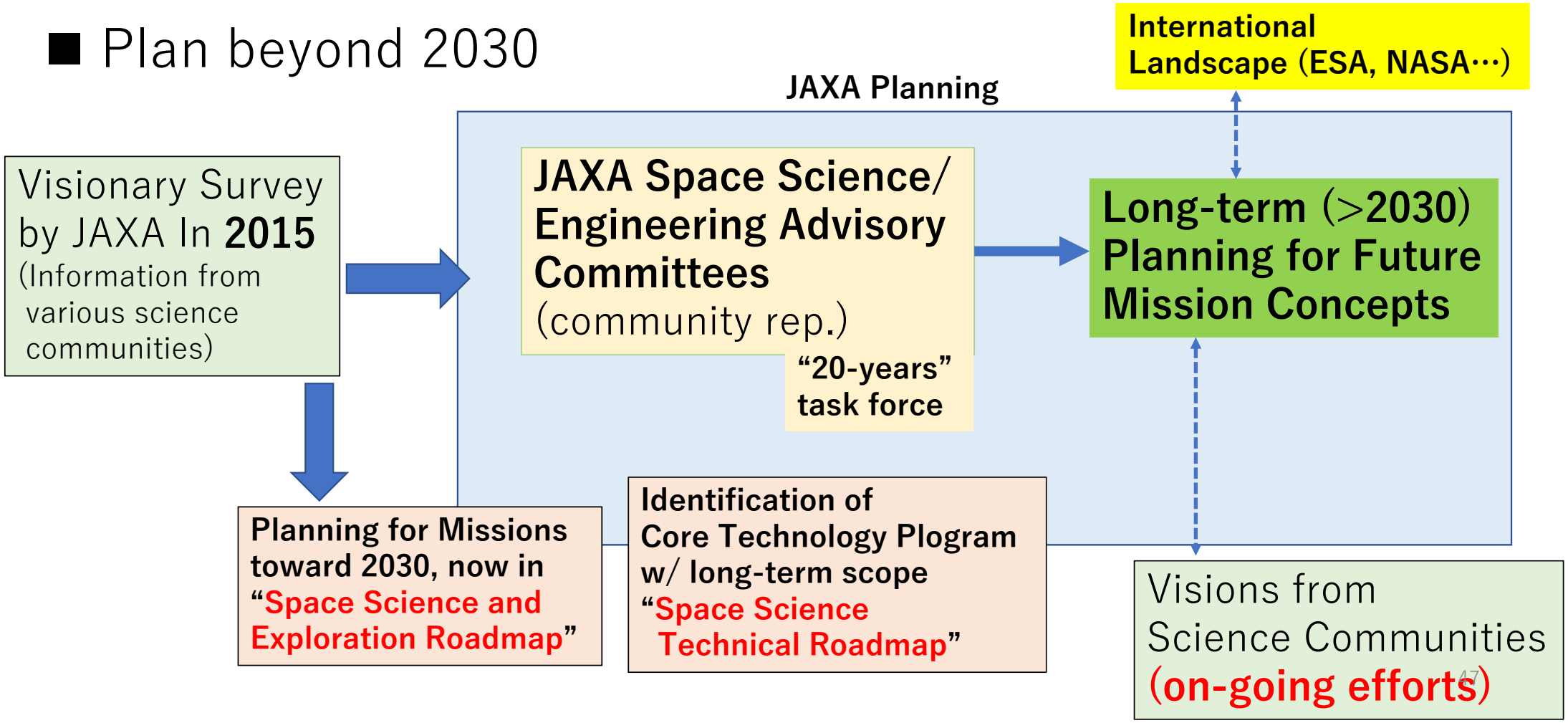
Planning for Future Science Mission in JAXA

■ Plan beyond 2030

- **JAXA-led** missions, with
  "appropriate" balance to **International-led** missions
- JAXA plans a "program-ed" sequence of missions
  which have synergies in science and/or technology
- Plan should fit with the JAXA's long-term vision
  for launcher service program

Planning for Future Science Mission in JAXA

■ Plan beyond 2030



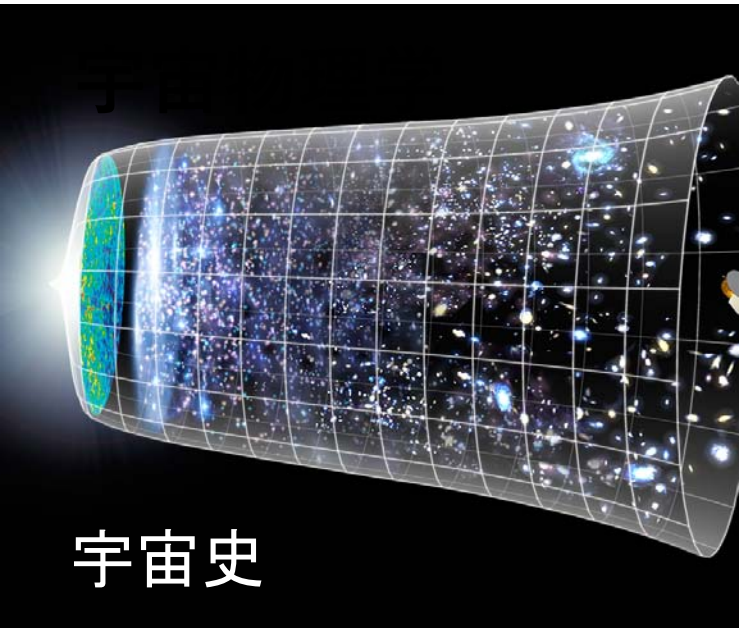
Visions over 2030

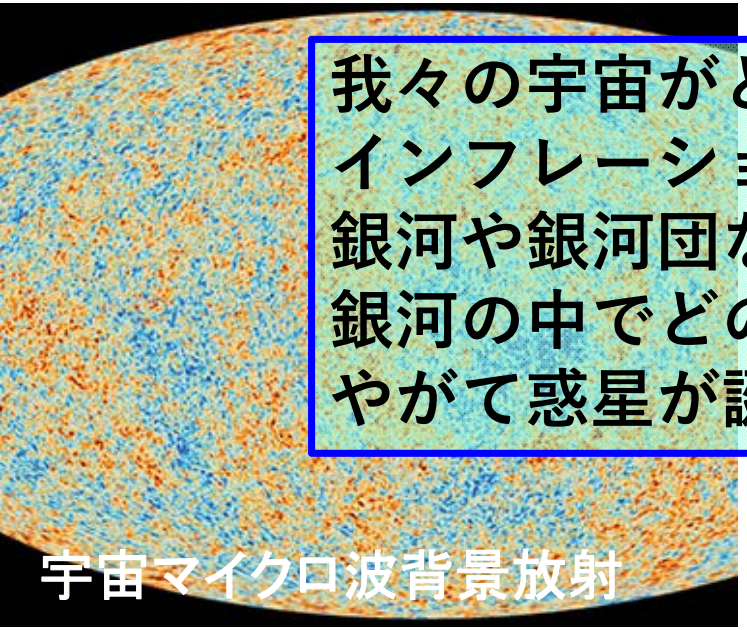
- **Key Science Fields : under discussions in communities**

- **JAXA-led "Sharp" science mission concepts:**
  - **Gravitational Wave [Deci-Hz]experiment**
  - **Space Infrared [or X-ray] Interferometer**
  - **X-ray Wide-field, high energy resolution**
  - **UV Wide-field**
  - **NIR Wide-field**
  - **Inter Planetary Space Telescope**

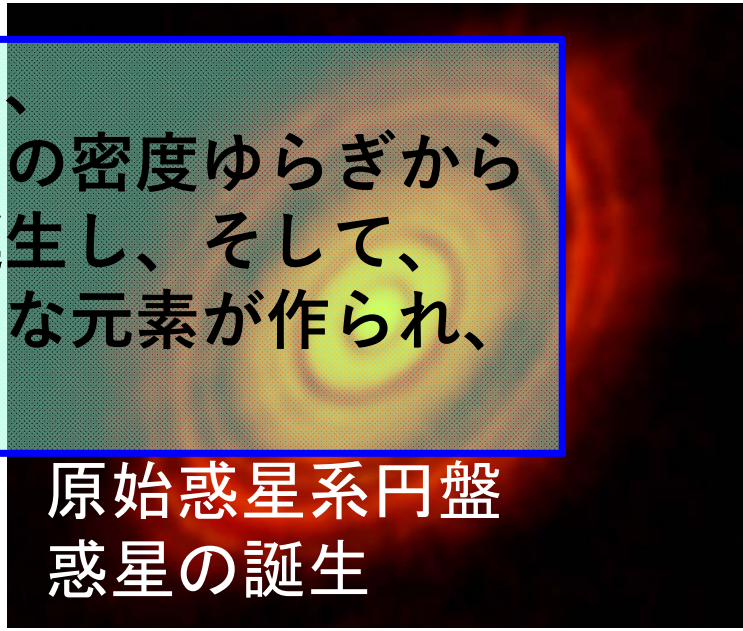
Identifying core technologies

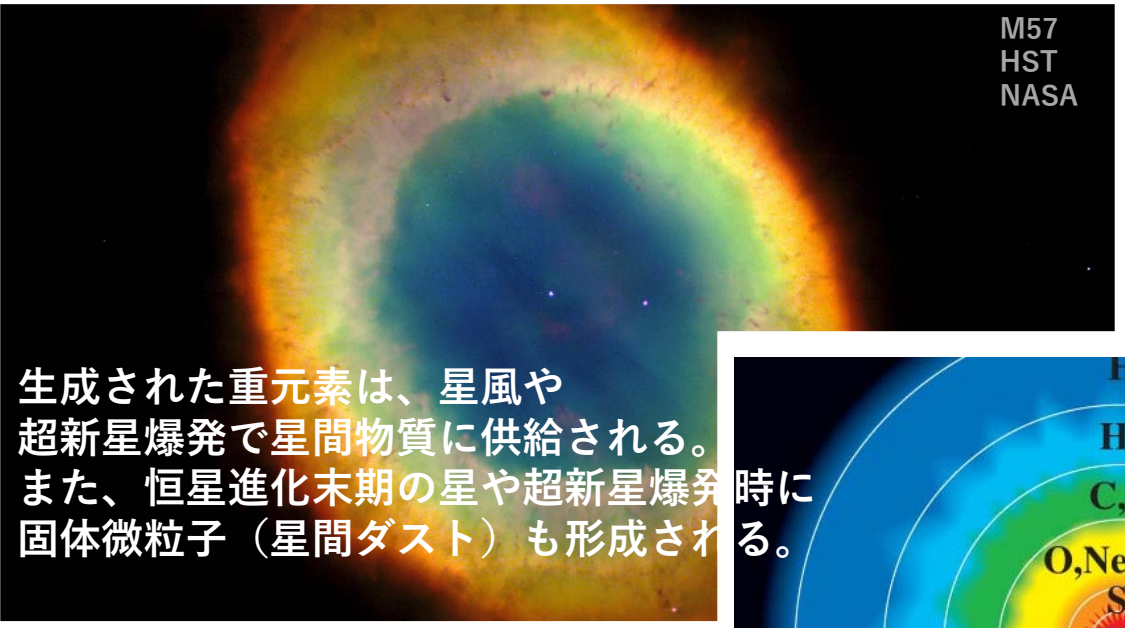
- **"International Mega Missions"**
  - **Instrument/Instrument subsystems**



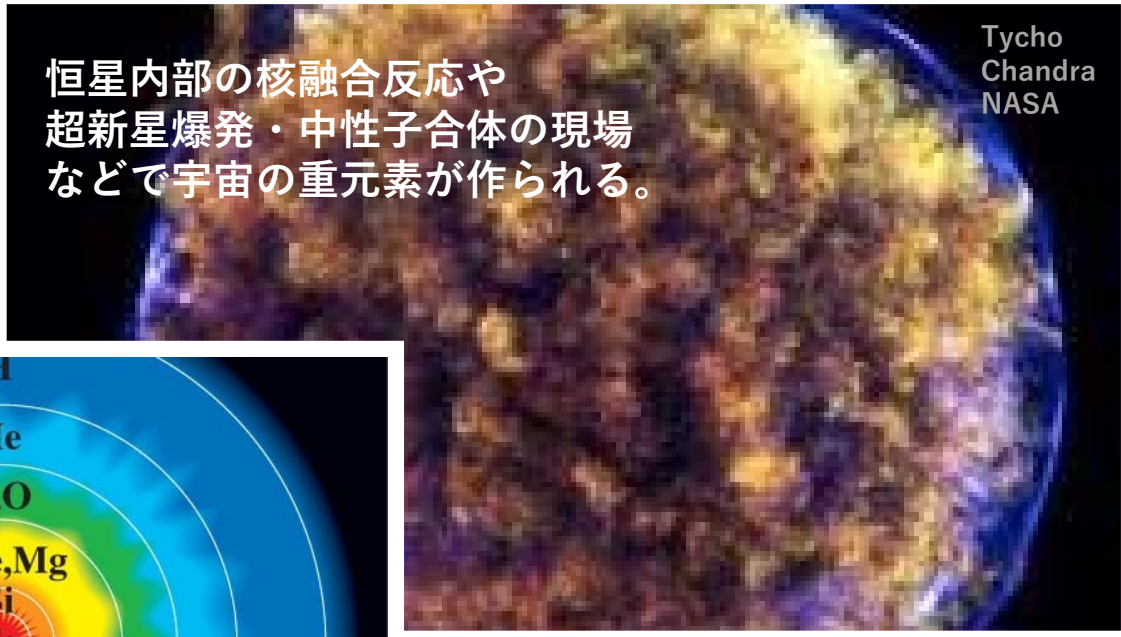


我々の宇宙がどのようにはじまり、また、
インフレーションで生成された宇宙初期の密度ゆらぎから
銀河や銀河団などの構造がどのように誕生し、そして、
銀河の中でどのように星は生まれ、様々な元素が作られ、
やがて惑星が誕生したのか？

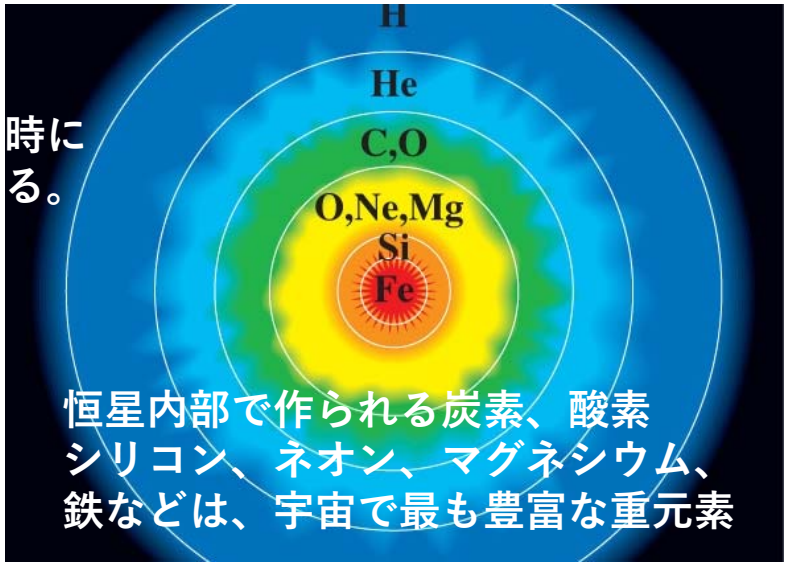




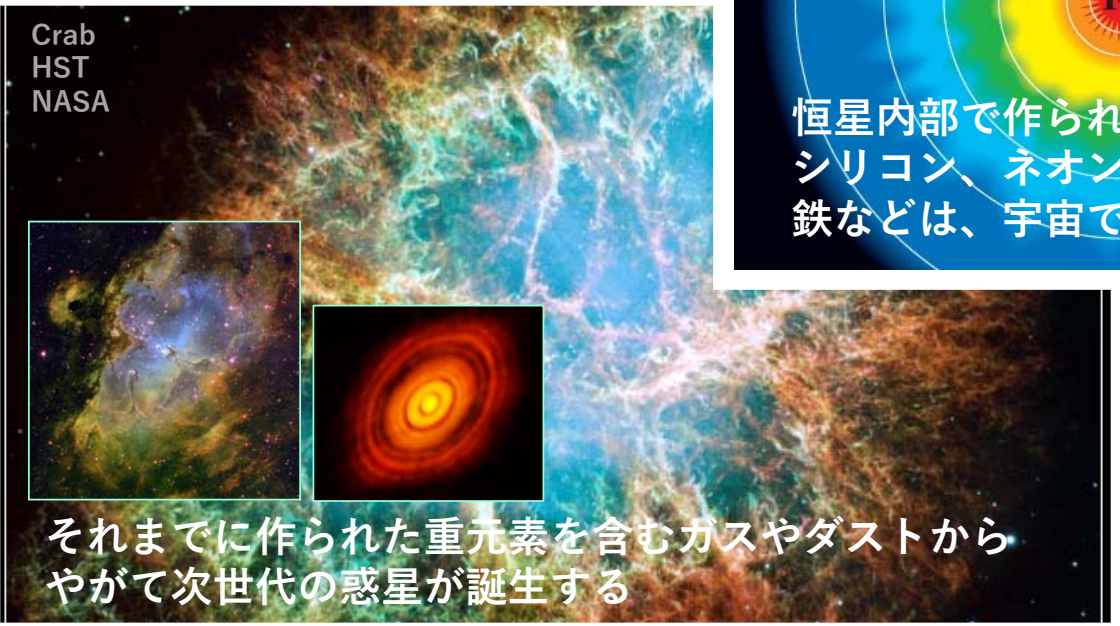
生成された重元素は、星風や
超新星爆発で星間物質に供給される。
また、恒星進化末期の星や超新星爆発時に
固体微粒子（星間ダスト）も形成される。



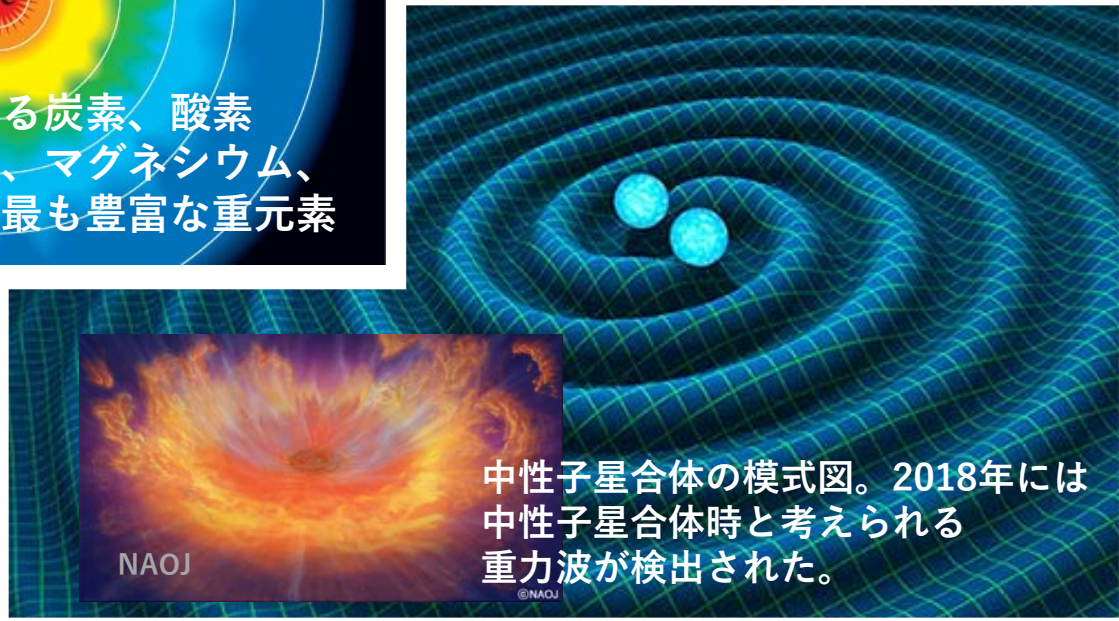
恒星内部の核融合反応や
超新星爆発・中性子合体の現場
などで宇宙の重元素が作られる。



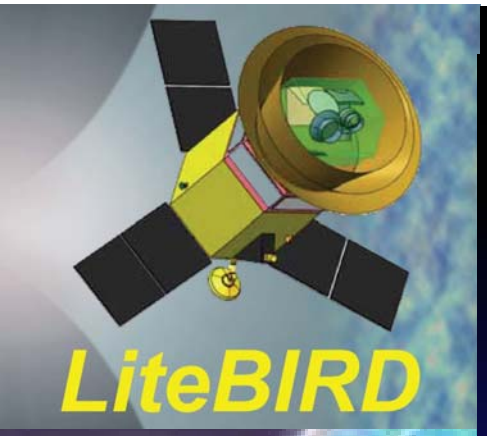
恒星内部で作られる炭素、酸素
シリコン、ネオン、マグネシウム、
鉄などは、宇宙で最も豊富な重元素



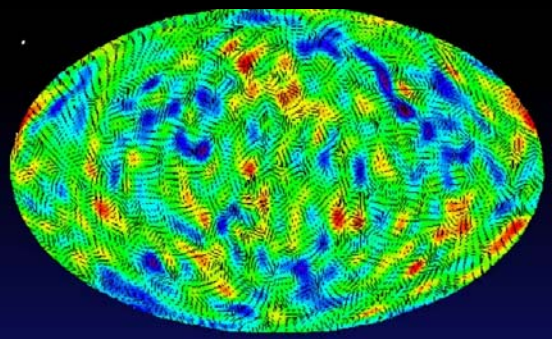
それまでに作られた重元素を含むガスやダストから
やがて次世代の惑星が誕生する



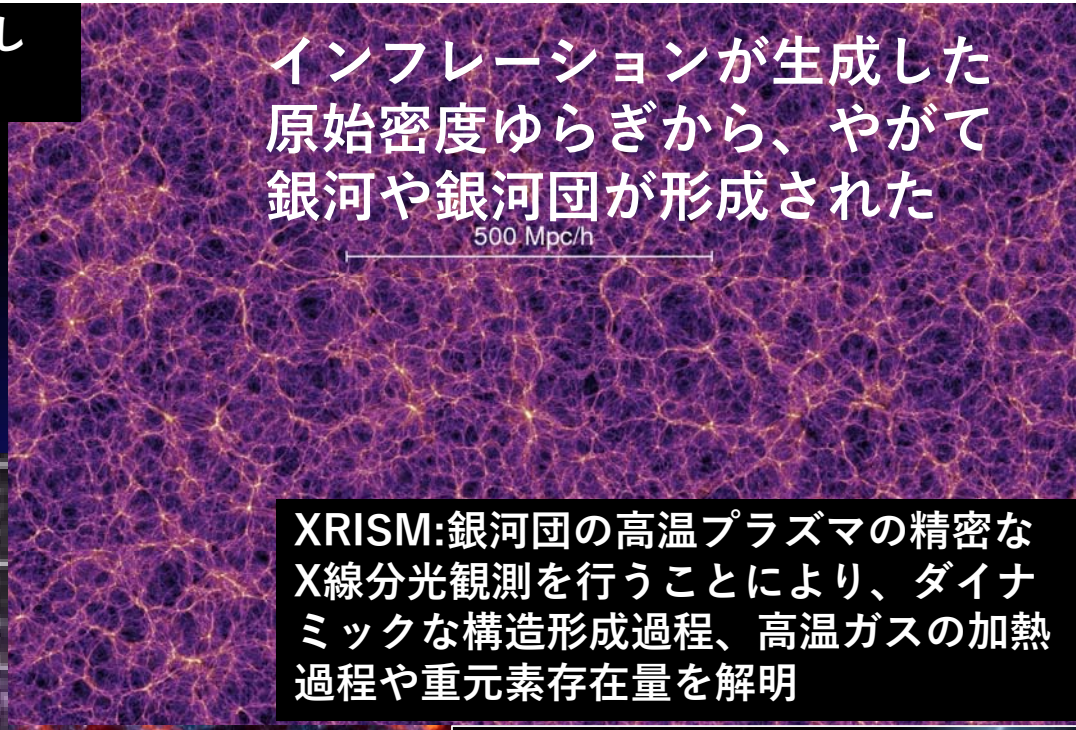
中性子星合体の模式図。2018年には
中性子星合体時と考えられる
重力波が検出された。



LiteBIRD:原始重力波の痕跡を観測してインフレーションを実証する



インフレーションが生成した原始密度ゆらぎから、やがて銀河や銀河団が形成された



XRISM:銀河団の高温プラズマの精密なX線分光観測を行うことにより、ダイナミックな構造形成過程、高温ガスの加熱過程や重元素存在量を解明

インフレーション

インフレーションが
・原始重力波を生成:
　　宇宙マイクロ波背景放射に痕跡
・宇宙の原始密度ゆらぎを生成
　　銀河・銀河団など構造の「種」

付録　NASA/ESA ミッションの枠組み

海外ミッション　NASA

A=Astrophysics
P=Planetary Science
H=Heliophysics

	分野	カテゴリ	総額	間隔	例
NASA	A	Flagship / Great Observatories	> $1-2B	~10年	HST (90), Compton (91), Chandra (99), Spitzer (03) , Fermi (08), JWST (21), WFIRST (25)
	A	Discovery	$425M	1-2年	Kepler (06)
	A	MIDEX	$180-200M+launch	~4年?	XTE(95), FUSE(98), WMAP(01), Swift(04), WISE(09), SPHEREx
	A	SMEX	$120M+launch	~4年?	SWAS(98), GALEX(03), NuSTAR(12)
	A	EX			TESS(18)
	H	MIDEX	$180-200M+launch	~4年?	ACE(97), IMAGE(00), THEMIS(07)
	H	SMEX	$120M+launch	~4年?	SAMPEX(92), FAST(96), TRACE(98), RHESSI(02), AIM(07), IBEX(08), IRIS(13)
	H	STP			TIMED(01), Hinode 06 [ISAS], STEREO(06), MMS(11)

	分野	カテゴリ	総額	間隔	例
NASA	P	Flagship	$1-2B	10年	Viking 1-2 (75), Voyager (77), Galileo(89), Cassini (97), Mars Science Laboratory (11), MARS2020 (20), Europa (?)
	P	New Frontier	~ $1B	~5年	New Horizons (06), JUNO (11), OSIRIS-Rex(16), Dragonfly
	P	Discovery	$425M+ Launch	1-2年	NEAR-Shoemaker (96), Luna Prospector (97), Stardust (99), Genesis (01), CONTOUR (03), Mars Pathfinder (03), MESSENGER (04), Deep Impact (05), EPOXI(05), DAWN (07), GRAIL(11), InSight (16)
	P	MARS Exploration (Mariner, Viking, Mars Surveyor' 98,			Mariner (62), Viking (75), Observer (92), Global Surveyor (96), Climate Orbiter (98), Polar Lander (99), Odyssey (01), Exploration Rover (Spilits, Opportunity) (03), Reconaissance Orbiter (05), Phoenix (07,SCOUT), Science Laboratory (Curriosity) (11), MAVEN (13, SCOUT)

今後の海外ミッションへの協力 (NASA)

	分野	カテゴリ	計画	日本の貢献	現状
NASA	A	Flagship / Great Observatories	JWST (21)	–	2021打ち上げ予定
			WFIRST (25)	WFIRST WG 住(大阪)、山田	LoI 準備中
			将来計画 (~30-35)	STDTオブザーバ	4分野での検討
	A	SMEX (AO 2016)	IXPE	玉川(理研)、他	NASA SMEX 提案、 ISAS 小規模採択 LoC 発出済、 PRAXyS ➔ IXPE
	A	EX	TESS (18)	研究者個別にチーム参加	JAXA 関与無し 2018 打ち上げ
	H	LWS	Solar Probe Plus (18)		

海外ミッションへの協力 (ESA)

	カテゴリ	総額	間隔	分野	例
ESA	Cosmic Vision – L	> €1B	~10年	P	JUICE (22)
				A	ATHENA (28)
				FP	L3 [LISA] (32)
	Cosmic Vision – M	€450–550M	~3年	H	Solar Orbiter (18)
				A	Euclid (21), PLATO (24)
				?	M4 (27), M5(29)
	Cosmic Vision – S			A	CHEOPS (17)
				H	SMILE (21)
	On-going			P	Bepi Colombo (18)
	In Operation / Previous			A	XMM(99), INTEGRAL(02), Herschel (09), Plank (09), GAIA (13)
				FP	LISA-Pathfinder (15)
				H	SOHO (95), PROBA2 (09)
				P	Huygens(97), Cluster(00), Double Star(03), Mars Express(03), Rosetta (04), Venus Express (05), ExoMars (16)

今後の海外ミッションへの協力 (ESA)

	カテゴリ	分野	計画	日本の貢献	現状
ESA	Cosmic Vision - L	P	JUICE (22)	小規模ミッション機器	Phase A相当
		A	ATHENA (28)	冷凍機など ATHENA WG	CCC-TPで検討など
		FP	L3 [LISA] (32)	-	DECIGOチームの協力可能性？
		?	L4 (?)	-	
	Cosmic Vision - M	A	Euclid (21)	すばる観測提案	JAXA コミット無し
			PLATO (24)	-	
		?	M4 (27)	-	ARIEL /
			M5(29)	SPICA PreProject	SPICA 提案 CORE+協力？
			M6 (?)		
	Cosmic Vision - S	A	CHEOPS (17)		
		H	SMILE (21)		
	On-going	P	Bepi Colombo (18)	MMO	2018 打ち上げ