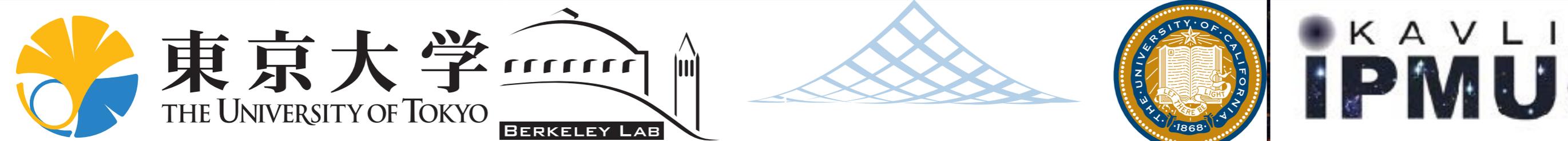


What is dark matter?

Comprehensive study of the huge
discovery space in dark matter

PI: Hitoshi Murayama (Kavli IPMU, Berkeley)

March 7, 2023



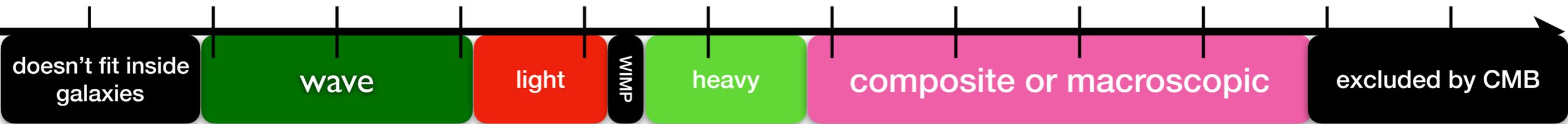
Main point: **Dark Matter exists**, but **unknown type of matter**

Search so far has been limited to **tiny range of masses**

neutrino electron **proton** bacteria mosquito human Mt. Fuji Earth Sun

mass of dark matter [GeV/c²]

10⁻⁴⁰ 10⁻³⁰ 10⁻²⁰ 10⁻¹⁰ 10⁰ 10¹⁰ 10²⁰ 10³⁰ 10⁴⁰ 10⁵⁰ 10⁶⁰ 10⁷⁰

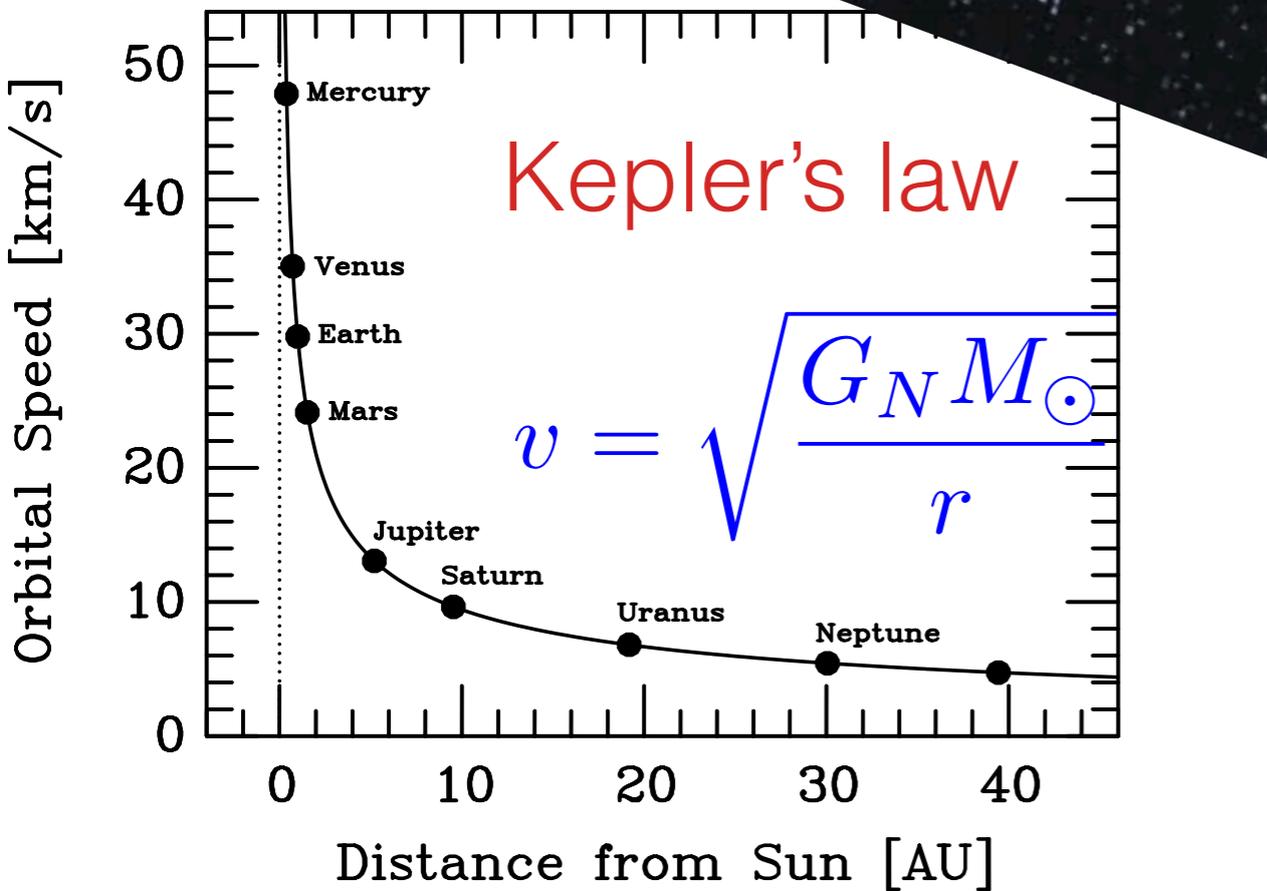
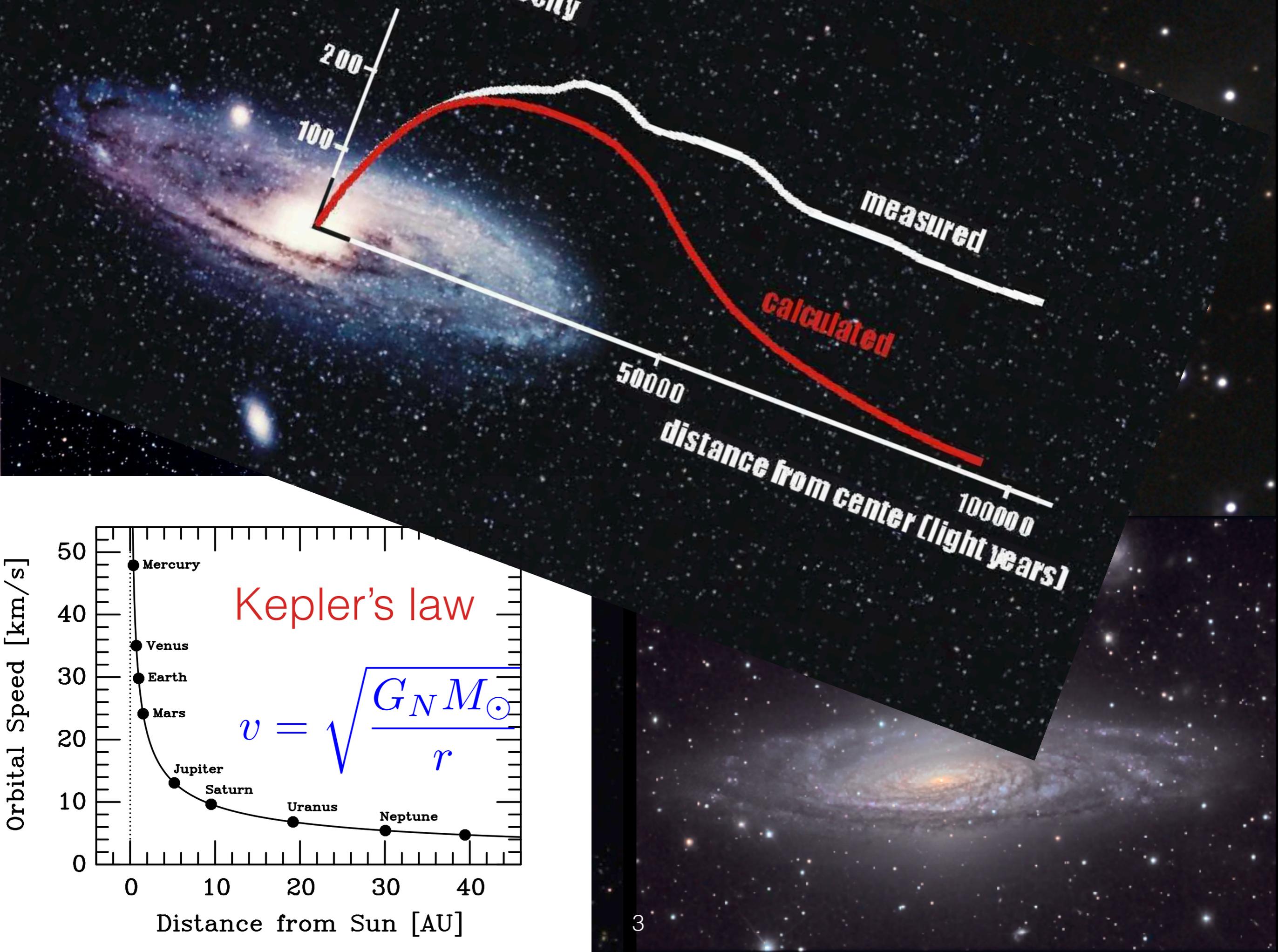


we challenge **discovery space** not studied so far due to theoretical prejudices

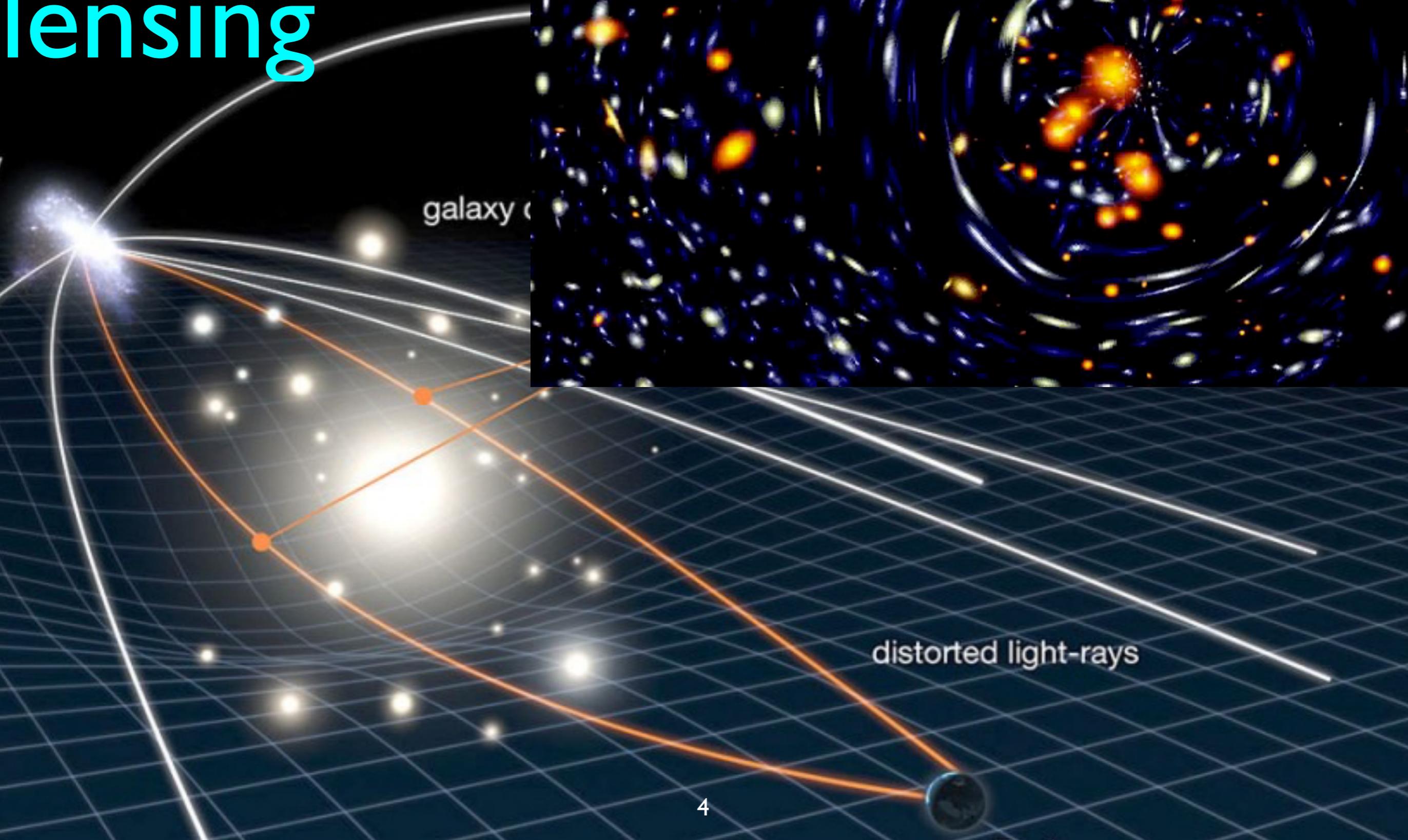
revolutionize dark matter research in Japan

cross-field research beyond traditional barriers

exploit existing facilities in unanticipated fashion



gravitational lensing



dark matter is our Mom



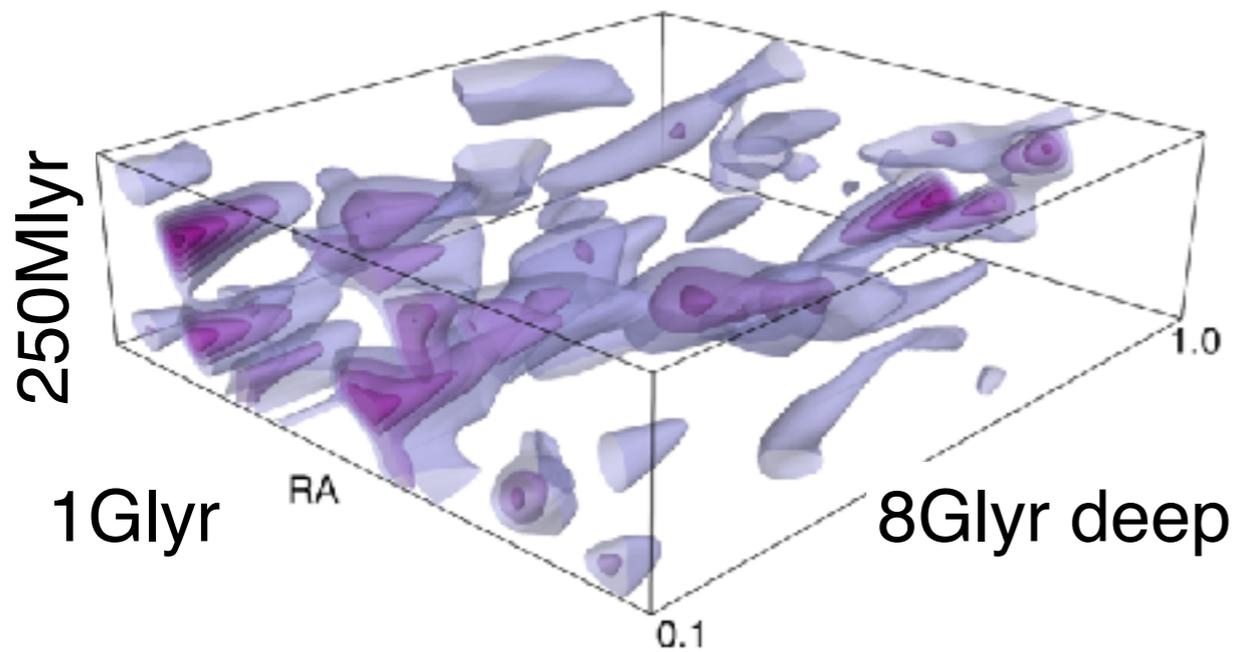
Jim Peebles
2019 Nobel Prize

without dark matter

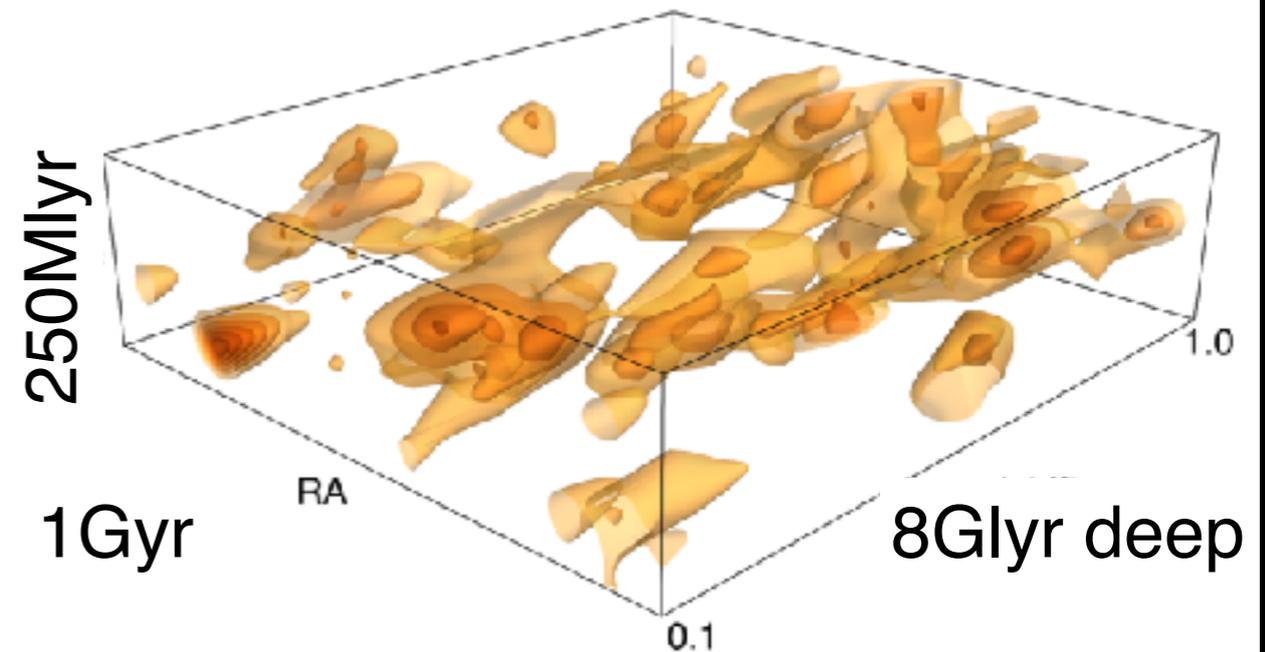
with dark matter

indeed our Mom!

dark matter



galaxies

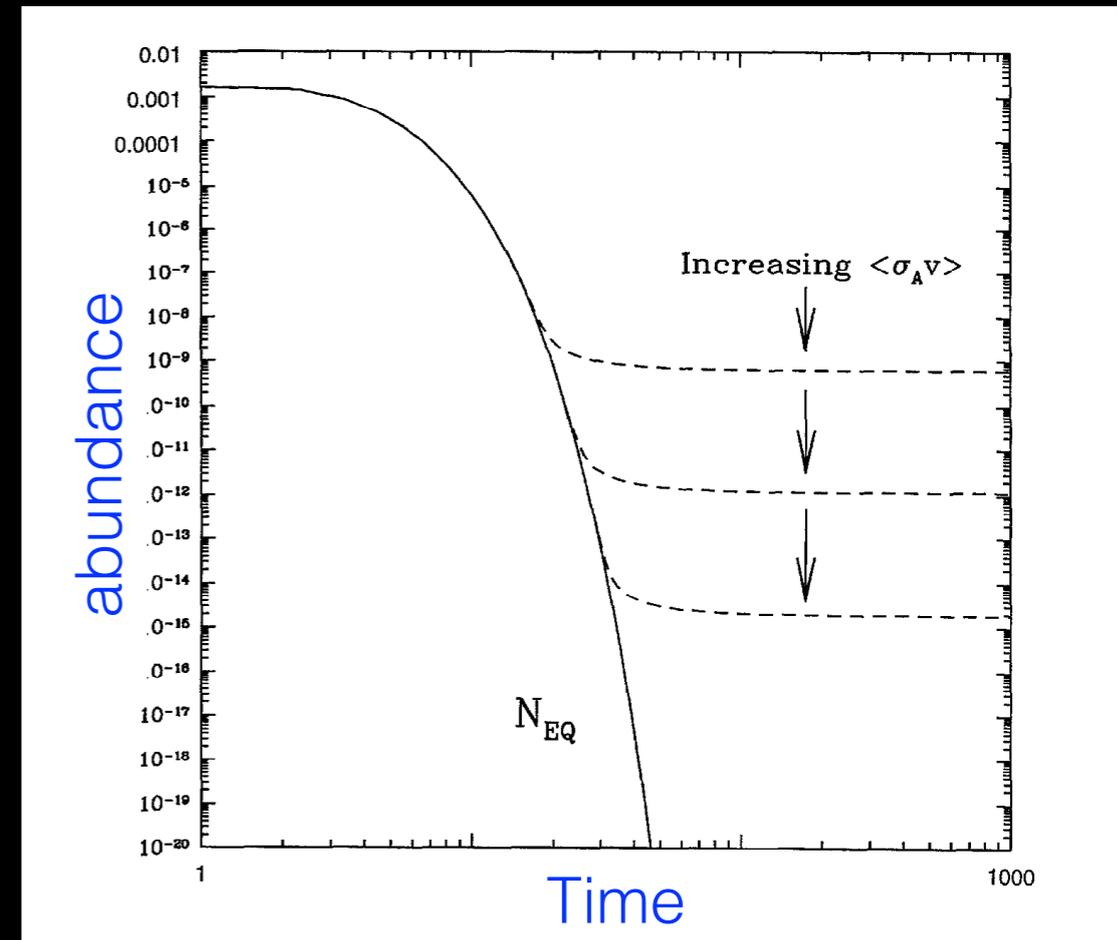
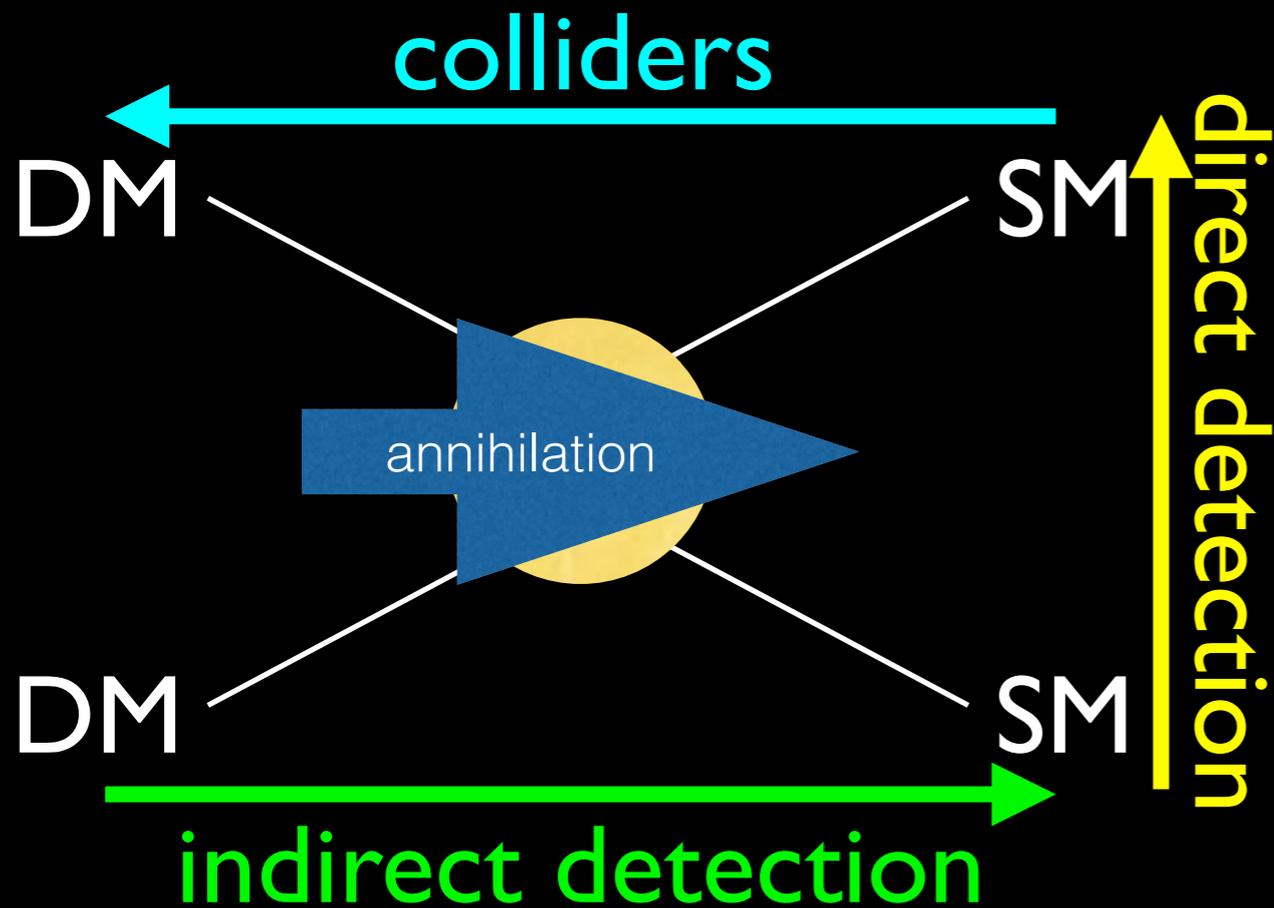


world's largest 3D map
of dark matter

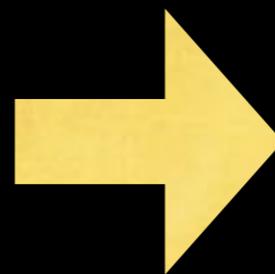


dominant paradigm: WIMP

Weakly Interacting Massive Particle

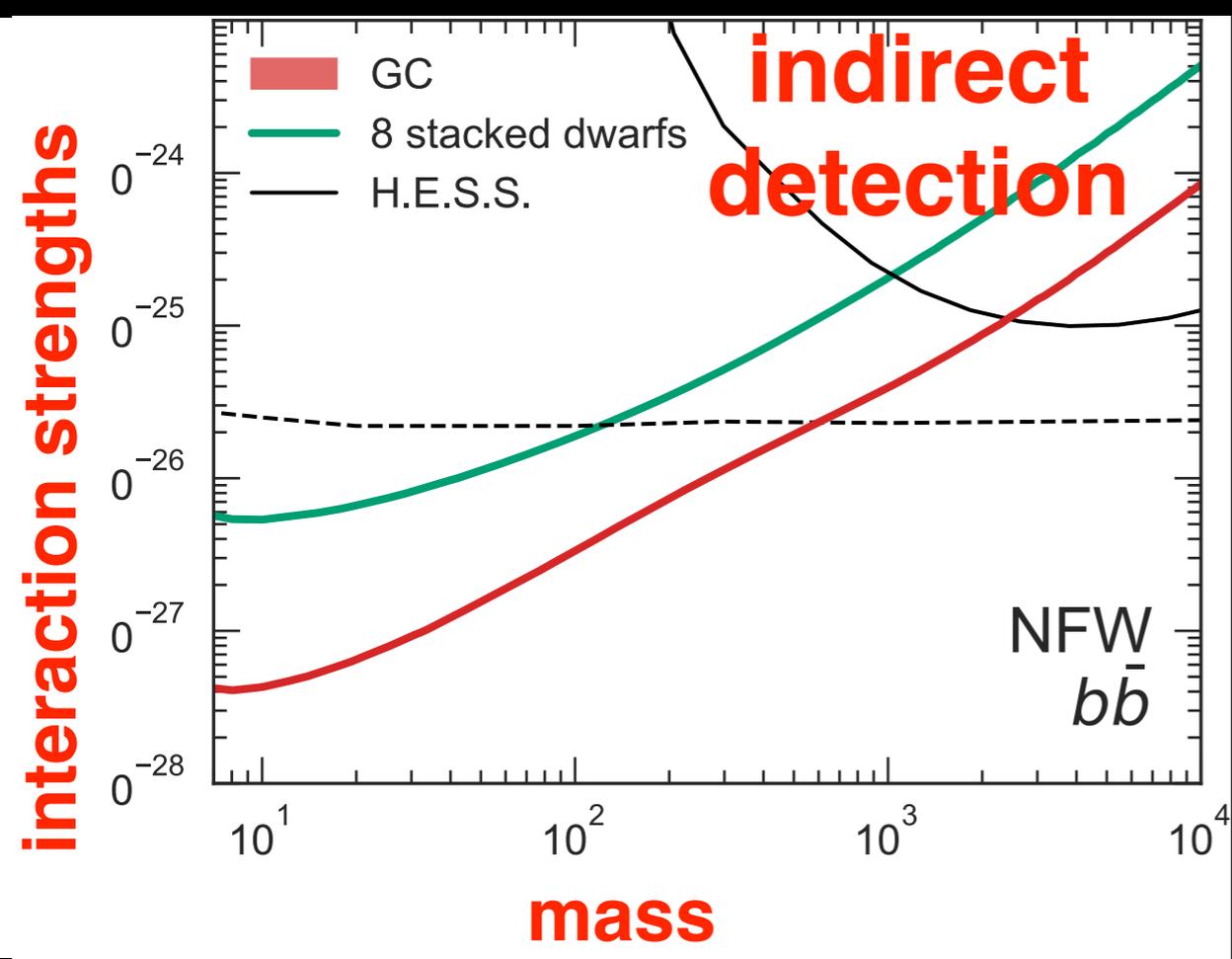
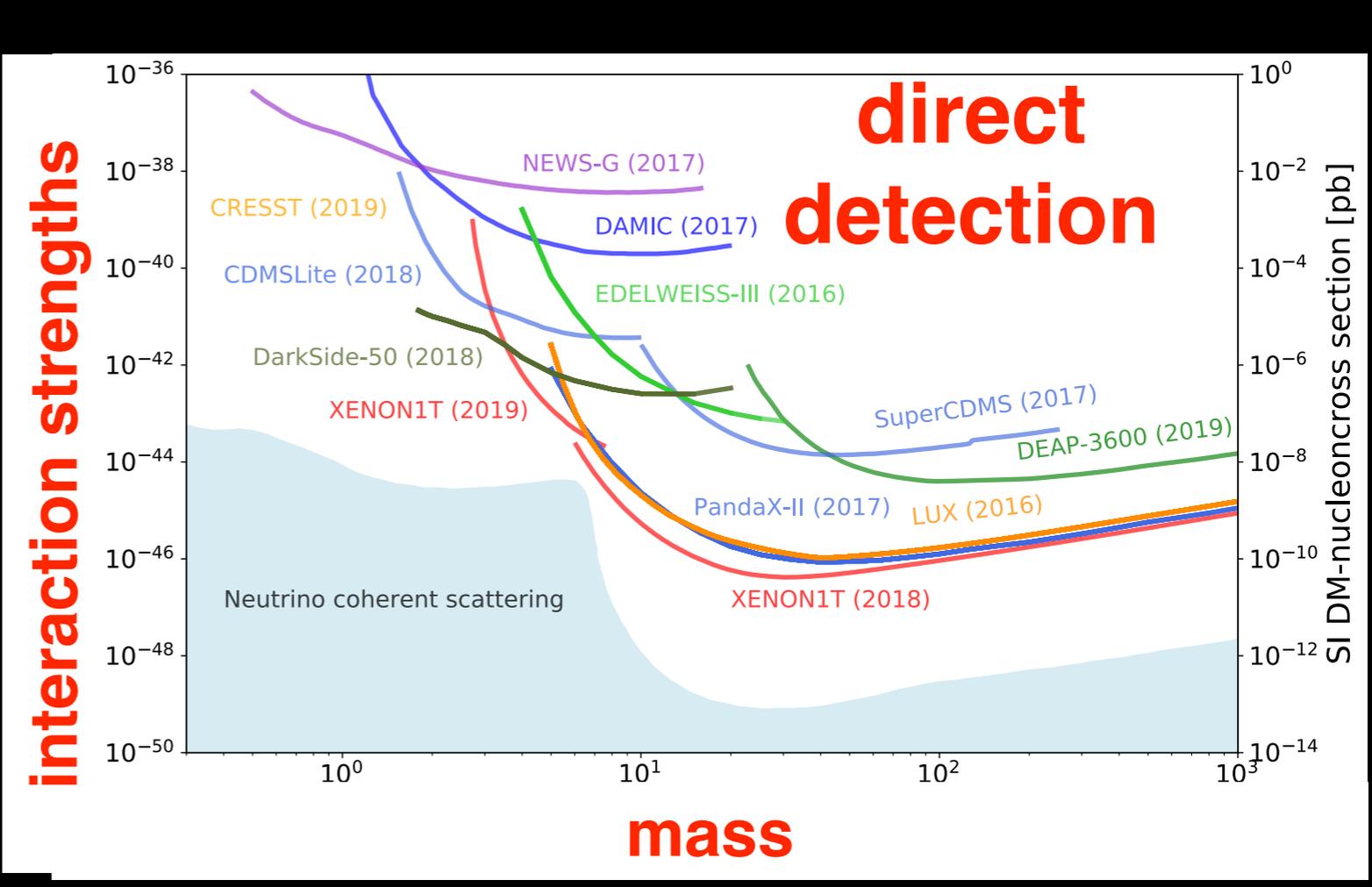
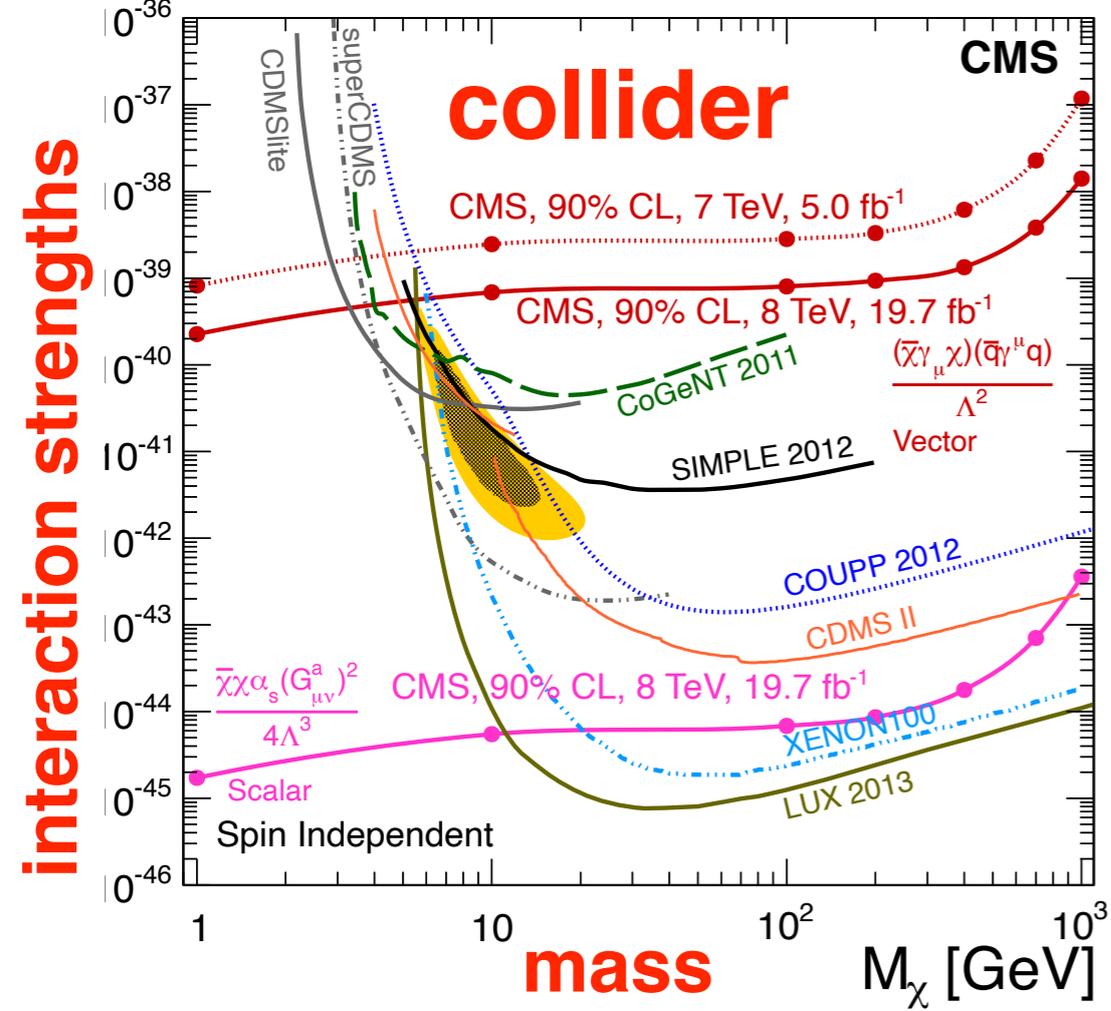


interaction strengths
energy scales



right abundance with
"weak interaction"

theoretical appealing, predicts 10~1000GeV mass
furthermore good mass range for LHC and UG expts



WIMP: theoretically appealing
 predicts 10~1000 GeV mass
 searches exclusively in this range
 most stringent limits today
 reflection: need broader search



strategy

- world competitive experiments > \$100M
- use excellent existing facilities in Japan
 - exploitation for unforeseen purposes
 - B01 : KAGRA (UTokyo) black hole mergers
 - B02, B03 : Subaru (NAOJ) galaxy evolution
 - B04 : XRISM (JAXA) supernova remnants
 - B05 : Belle II (KEK) CP violation
 - B06 : Simons Array (intl team incl KEK, IPMU etc) verify inflation theory

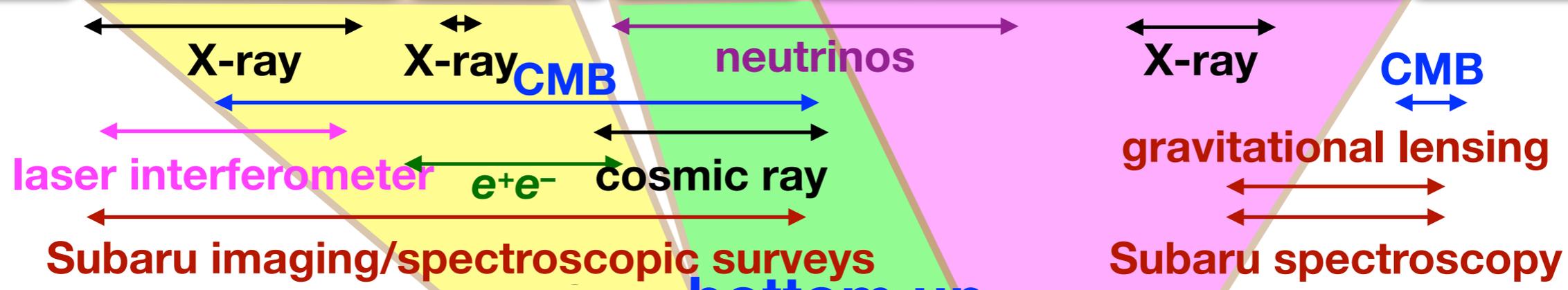


[X00] 総括班 村山 (KIPMU)	[A01]軽いDM 高橋 (東北大)	[A02]重いDM 村瀬 (PSU)	[A03]マクロDM 柳 (名古屋大)	[C02]宇宙構造形成理論 安藤 (アムステルダム大)
[B01] レーザー干渉計 道村 (東大)	axion, dilaton (円偏光)	背景重力波 (相転移など)	背景重力波 (inflationなど)	
[B02] すばる分光 高田 (KIPMU)	fuzzy DM, SIDM 3D DM地図	矮小銀河内の対消滅 3D DM地図	PBH, UCMH, DM subhalo, 3D DM地図	
[B03] イメージング 宮崎 (NAOJ)	DM subhalo DM地図	DM subhalo DM地図	PBH, UCMH (重カマイクロレンズ)	
[B04] X線 山崎(典) (ISAS)	sterile neutrino moduli (輝線、連続光)	ダークマター崩壊 (輝線、連続光)	PBH蒸発 (X線背景放射)	
[B05] e^+e^- 加速器 西田 (KEK)	dark photon SIMP	高エネルギーの間接検証 (余剰次元、Higgs)	高エネルギーの間接検証 (余剰次元、Higgs)	
[B06] CMB 小松 (MPA)	axion (CMB偏光)	宇宙初期の対消滅 N_{eff}	PBH (τ)	
[C01]量子重力理論 山崎(雅) (KIPMU)				

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bottom up

laser interferometer

Subaru spectroscopy

Subaru imaging

X-ray satellite

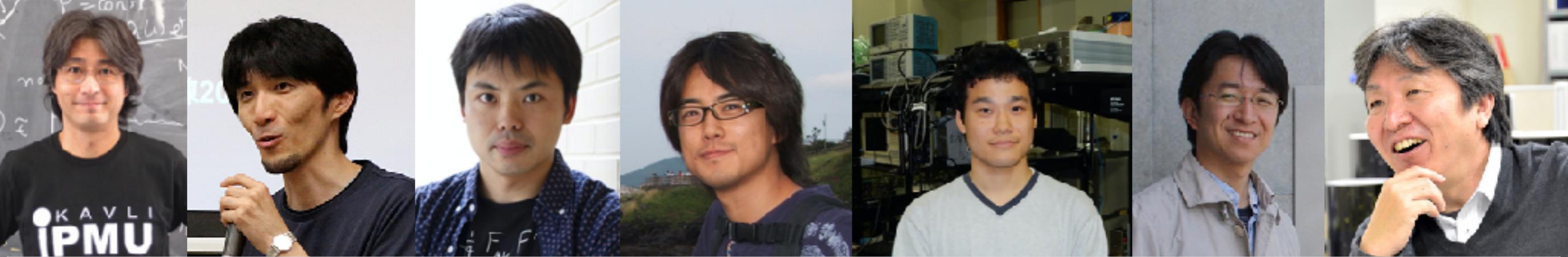
e+e- collider

CMB

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top down
structure
formation
theory

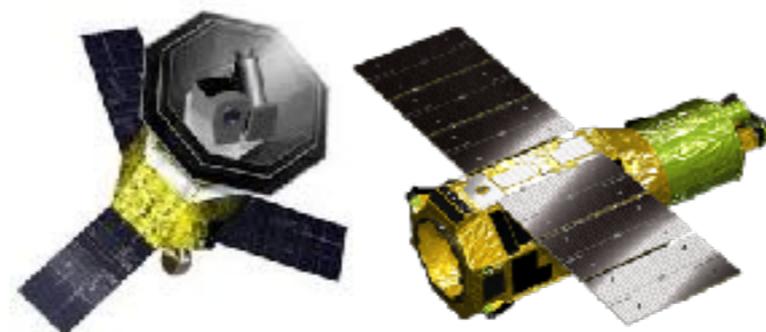
quantum gravity



manage	Murayama	Kavli IPMU / UC Berkeley	particle/cosmology
A01	Takahashi	Tohoku	particle
A02	Murase	Penn State / Kyoto	astrophysics
A03	Yoo	Nagoya	relativity cosmology
B01	Michimura	UTokyo Physics	experiment
B02	Takada	Kavli IPMU	cosmology/astro
B03	Miyazaki	NAOJ	obs. cosmology
B04	Yamasaki	JAXA/ISAS	experiments
B05	Nishida	KEK	experiments
B06	Komatsu	Max Planck / Kavli IPMU	cosmology
C01	Yamazaki	Kavli IPMU	string theory
C02	Ando	Amsterdam / Kavli IPMU	particle astrophysics



space



theory
light DM
heavy DM
macro DM

expts
laser interferometry
Subaru imaging & spectroscopy
-ray, colliders
CMB

ultimate
quantum gravity
structure formation

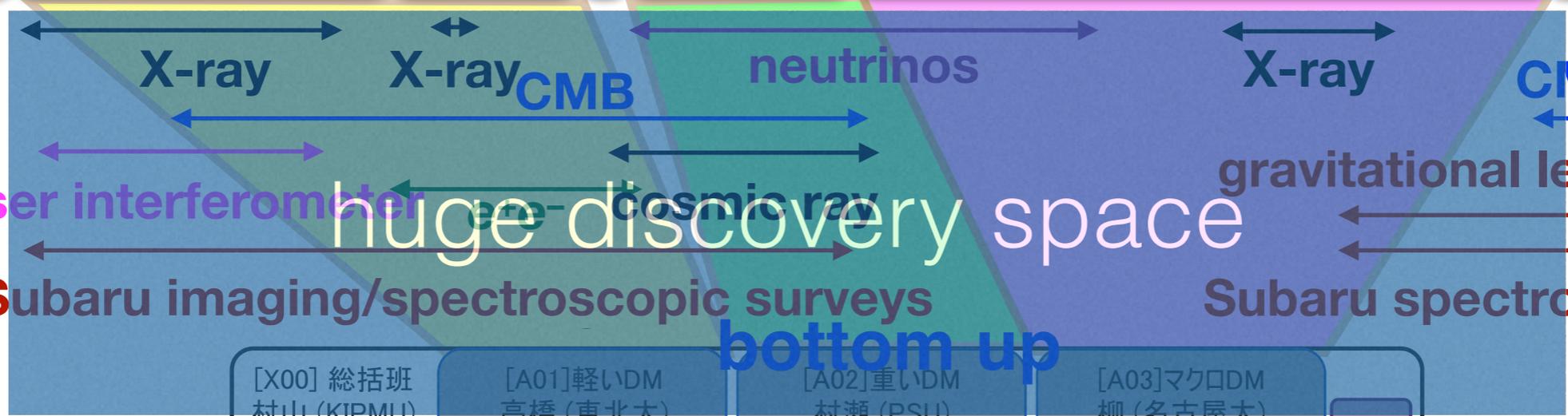
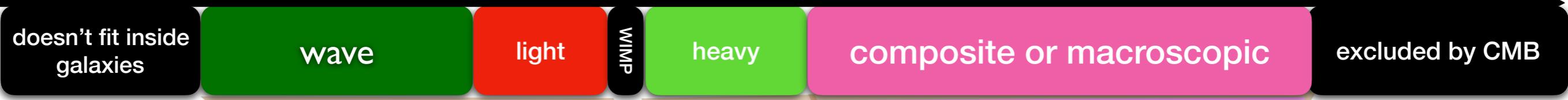
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top down structure formation theory

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*Looking forward to
seeing progress!*