

DIOSで探る宇宙の大構造とダークバリオン

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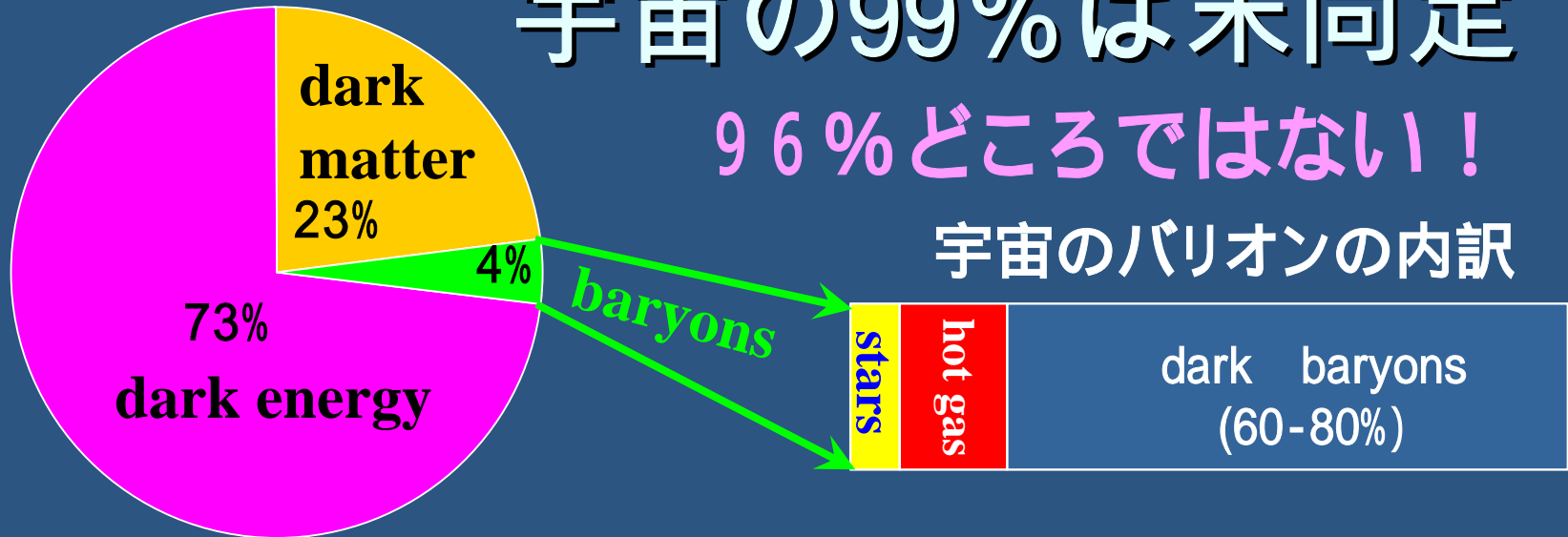
田原讓、古澤彰浩 (名大理)

他 DIOSグループ

宇宙の99%は未同定

96%どころではない！

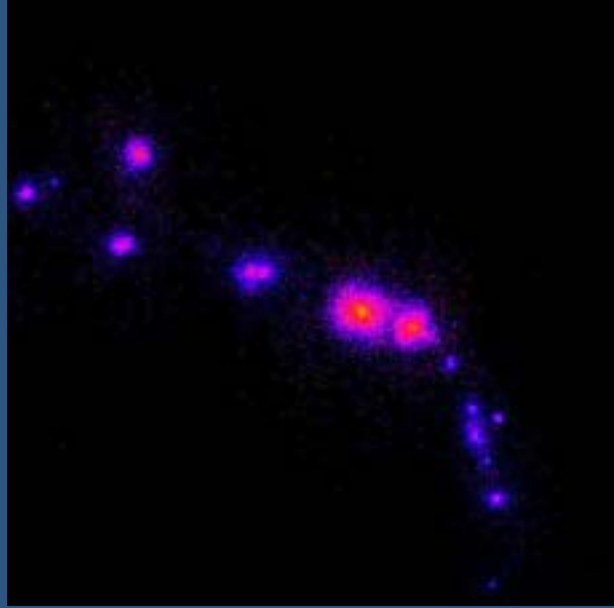
宇宙のバリオンの内訳



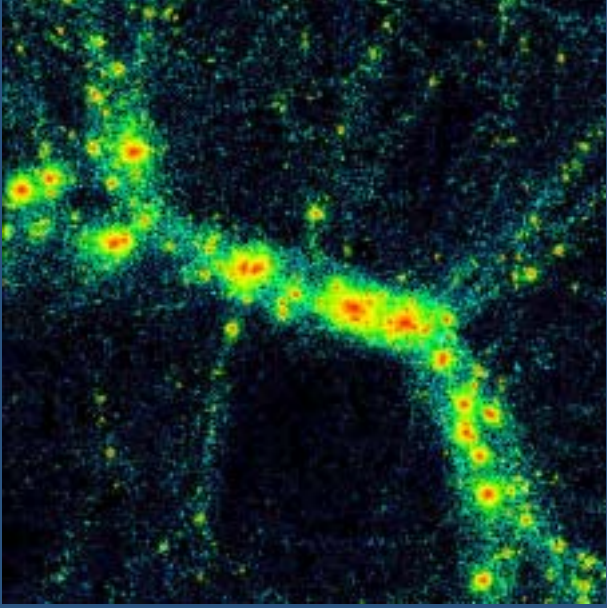
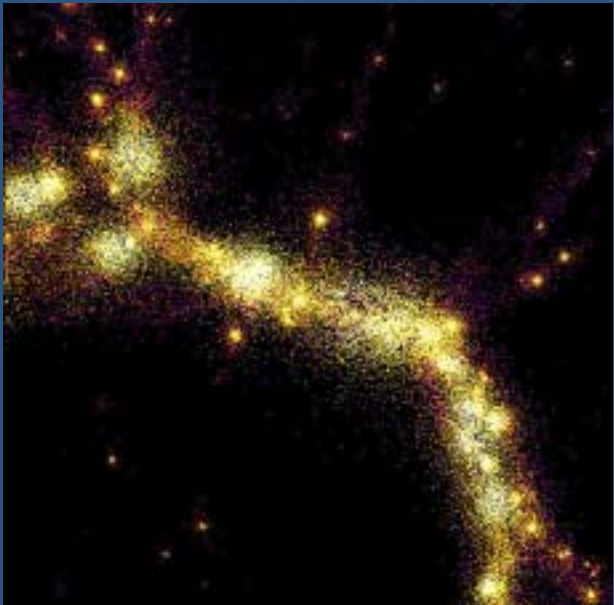
Component	Central	Maximum	Minimum	Grade ^a
Cosmic Baryon Budget: Fukugita, Hogan & Peebles: ApJ 503 (1998) 518				
1. Stars in spheroids	0.0026 h_{70}^{-1}	0.0043 h_{70}^{-1}	0.0014 h_{70}^{-1}	A
2. Stars in disks	0.00086 h_{70}^{-1}	0.00129 h_{70}^{-1}	0.00051 h_{70}^{-1}	A-
3. Stars in irregulars	0.000069 h_{70}^{-1}	0.000116 h_{70}^{-1}	0.000033 h_{70}^{-1}	B
4. Neutral atomic gas	0.00033 h_{70}^{-1}	0.00041 h_{70}^{-1}	0.00025 h_{70}^{-1}	A
5. Molecular gas	0.00030 h_{70}^{-1}	0.00037 h_{70}^{-1}	0.00023 h_{70}^{-1}	A-
6. Plasma in clusters	0.0026 $h_{70}^{-1.5}$	0.0044 $h_{70}^{-1.5}$	0.0014 $h_{70}^{-1.5}$	A
7a. Warm plasma in groups	0.0056 $h_{70}^{-1.5}$	0.0115 $h_{70}^{-1.5}$	0.0029 $h_{70}^{-1.5}$	B
7b. Cool plasma	0.002 h_{70}^{-1}	0.003 h_{70}^{-1}	0.0007 h_{70}^{-1}	C
7'. Plasma in groups	0.014 h_{70}^{-1}	0.030 h_{70}^{-1}	0.0072 h_{70}^{-1}	B
8. Sum (at $h = 70$ and $z \simeq 0$).....	0.021	0.041	0.007	...

宇宙の物質分布 (SPH simulation)

銀河団高温ガス



ダークバリオン



ダークマター



銀河

Yoshikawa et al. (2001)

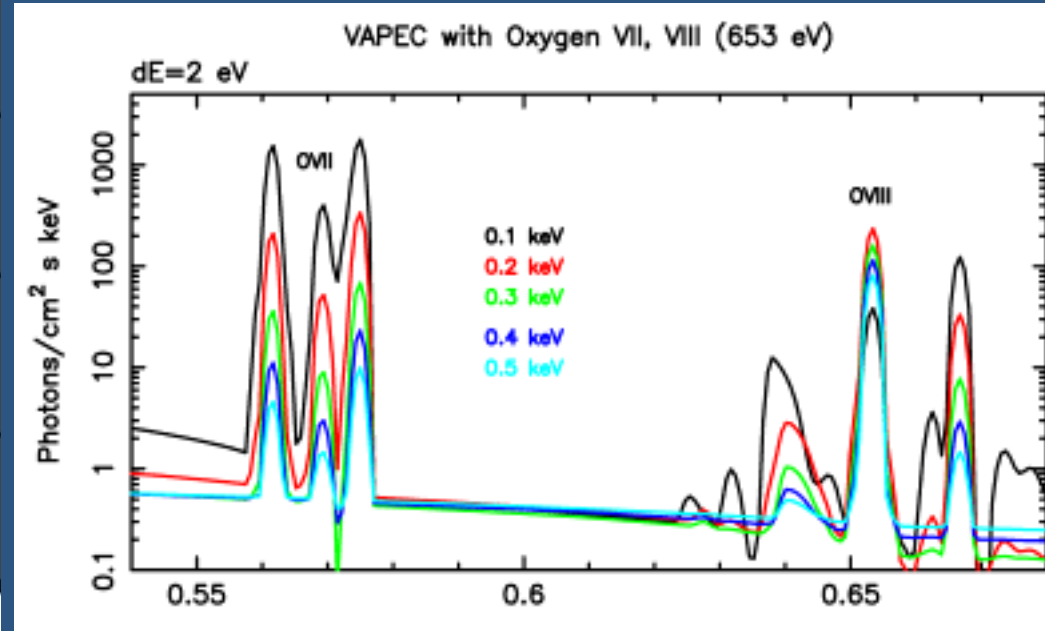
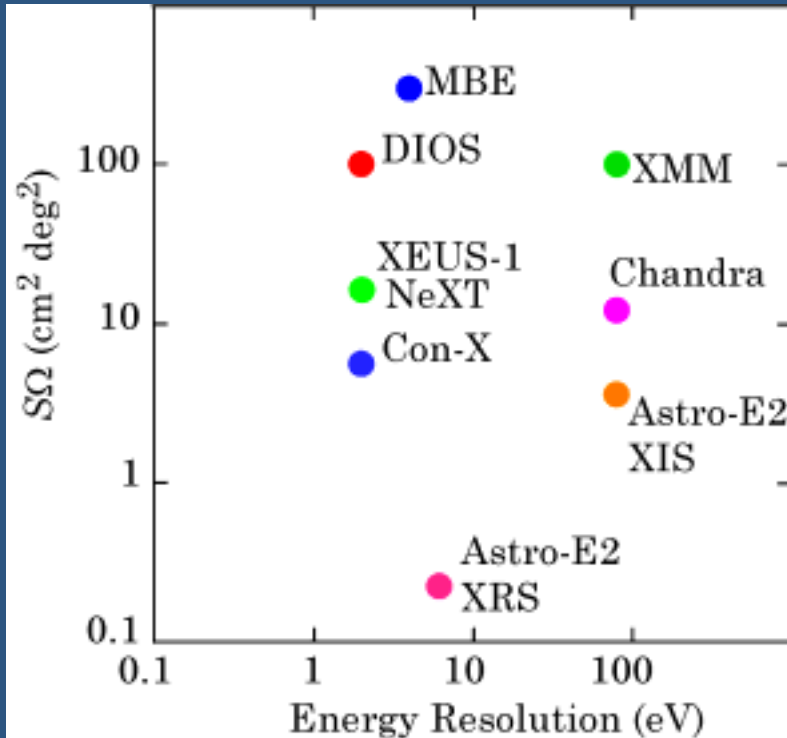
DIOS: Diffuse Intergalactic Oxygen Surveyor

A Japanese proposal of a dedicated X-ray mission to search for dark baryons



- A dedicated satellite with cost < 40M USD to fill the gap between Astro-E2 (2005) and NeXT (2010?). Launch at Japan in 2008 (?).
- Unprecedented energy spectral resolution $\Delta E=2\text{eV}$ in soft X-ray band (0.1-1keV)
- Aim at detection of (20-30) percent of the total cosmic baryons via Oxygen emission lines
- PI: Takaya Ohashi (Tokyo Metropolitan Univ.)

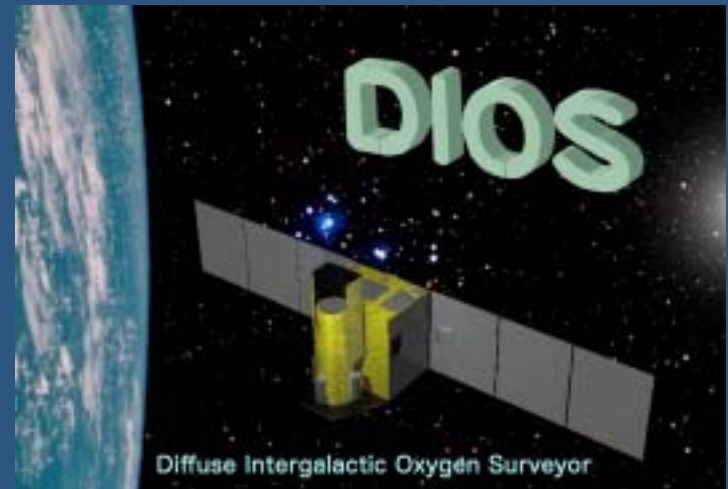
DIOS: comparison with other missions



- Very high sensitivity ($S\Omega$ and ΔE) in detecting oxygen emission lines
- Intensity ratios of the lines reveal the temperature and ionization condition of WHIM ($10^5\text{K} < T < 10^7\text{K}$)

Detecting Warm-Hot Intergalactic Medium via Oxygen emission lines

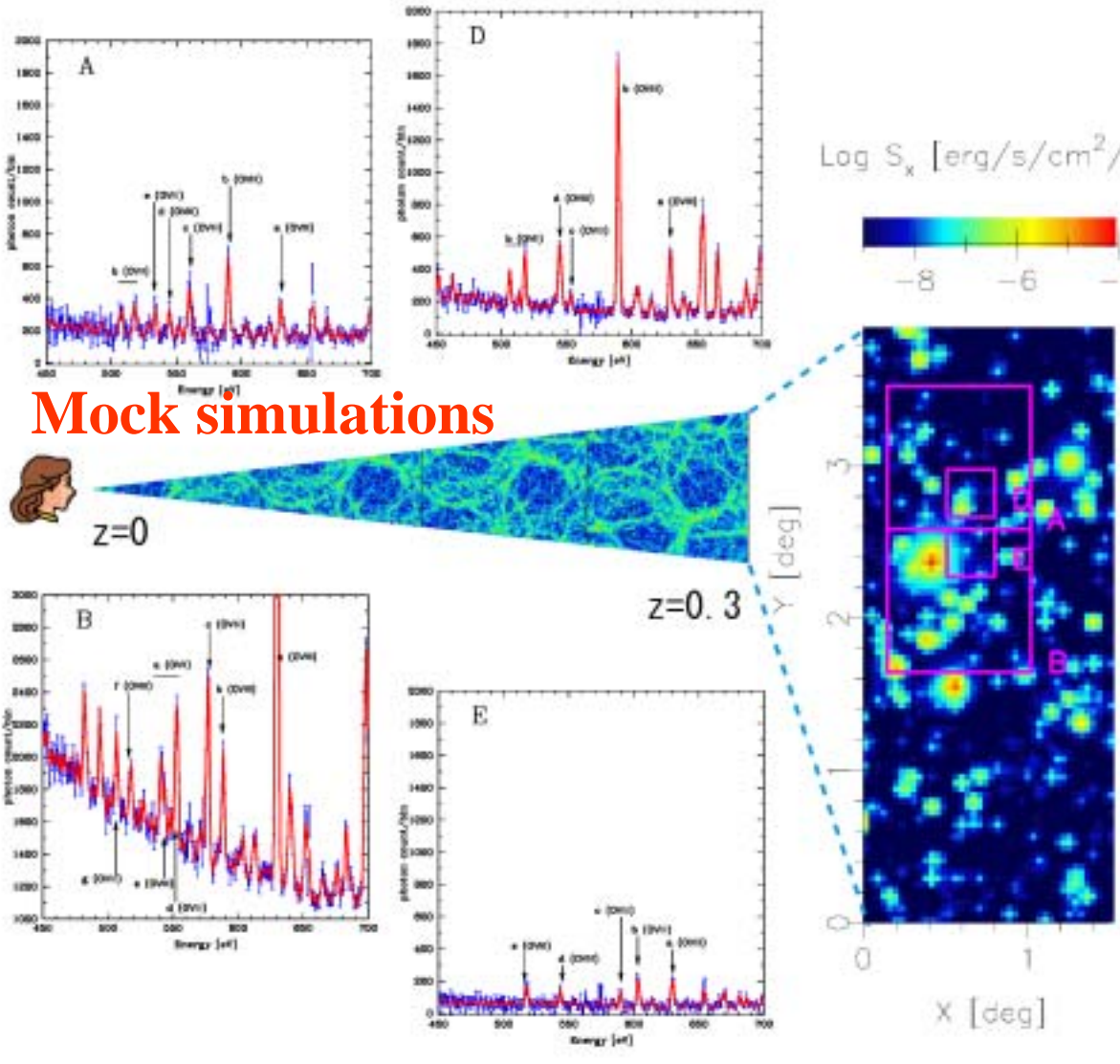
- Mock spectra from cosmological SPH simulation
- **With our proposed mission (20-30) % of the total cosmic baryons will be detected via Oxygen emission lines** in principle.
 - $\Delta E = 2\text{eV}$ ($0.1\text{keV} < E < 1\text{keV}$)
 - $\Delta\theta = 3$ arcmin
 - $\text{FOV} = 50 \times 50 \text{arcmin}^2$
 - $S_{\text{eff}} \Omega = 100$ [$\text{cm}^2 \text{deg}^2$]
- Identifying the major fraction of dark baryons



Searching for dark baryons with DIOS (Diffuse Intergalactic Oxygen Surveyor)



Yoshikawa et al.
PASJ 55 (2003) 879



Mock simulations



z=0

z=0.3

DIOSグループ

都立大理: **大橋隆哉**

石田學、佐々木伸、石崎欣尚

宇宙研: 山崎典子、満田和久

藤本龍一、古庄多恵

名大理: 田原讓、古澤彰浩

東大理: 須藤靖、吉川耕司

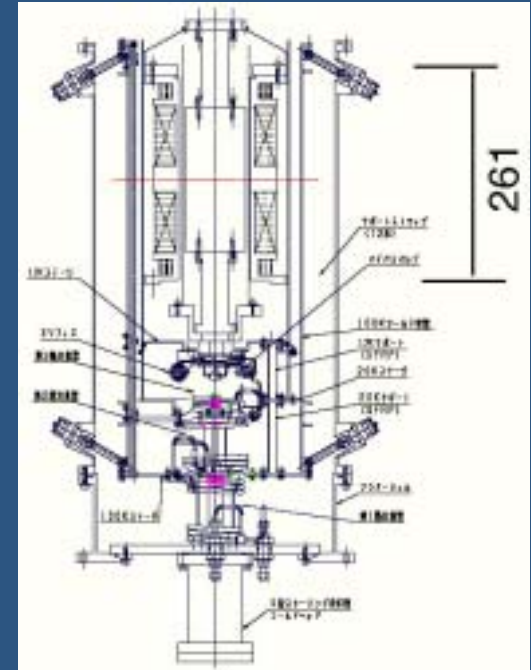
他 (募集中)

展望

- **宇宙のダークバリオン探査**
 - たかが3%、されど3%
 - 酸素輝線によるダークバリオンサーベイ ($0.1 < z < 0.3$)
 - 背景QSOの酸素吸収線系サーベイ
 - 近傍宇宙の銀河団周縁部サーベイ ($z < 0.1$)
- **軟X線精密分光による新しいサイエンスの開拓**
 - $\Delta E = 2\text{eV}$ ($0.1\text{keV} < E < 1\text{keV}$)
 - $\Delta\theta = 3\text{ arcmin}$ ($\text{FOV} = 50 \times 50\text{ arcmin}^2$)
 - 銀河系内元素循環のダイナミクス
- **アイディア・参加者・予算提供者・研究費 募集中**

DIOS: instrument summary

Area	$> 100 \text{ cm}^2$
Field of View	50' diameter
$S \Omega$	$\sim 100 \text{ cm}^2 \text{deg}^2$
Angular Resol.	3' (16² pixels)
Energy Resol.	2 eV (FWHM)
Energy Range	0.1 - 1 keV
Life	$> 5 \text{ yr}$



Mechanical coolers
 + ADR: $< 100 \text{ mK}$
 Initial cooling
 $\sim 3 \text{ months}$

DIOS: spacecraft

Weight	Total	~ 400 kg
	Payload	~ 280 kg
Size	Launch	1.2 × 1.45 × 1.4 m
	In orbit	5.85 × 1.45 × 1.4 m
Attitude	Control	3-axis bias momentum wheel, Sun pointing in 1 axis
	Accuracy	10 arcsec
Power	Total	450 W
	Payload	250 W

Altitude: ~ 550 km

Inclination: 30 °

Rotation period: 95 min

