# LiteBIRD - a future satellite for the studies of B-mode polarization and Inflation from cosmic background Radiation Detection

Masashi Hazumi (KEK, Japan)

2013/10/15

#### Lite (Light) Satellite for the Studies of B-mode Polarization and Inflation from Cosmic Background Radiation Detection

- Candidate for JAXA's future missions on "fundamental physics"
- JAXA-based working group (more than 60 members from JAXA, Kavli IPMU, KEK, NAOJ, Berkeley/LBNL, McGill, Riken, MPA and Japanese universities)
  Open to international collaborations
  - Observations
    - Full-sky CMB polarization survey at a degree scale (30arcmin @ 150 GHz)
    - 6 bands b/w 50 and 320 GHz
  - Scientific objectives
    - Check representative inflationary models (any model w/ r>0.002)
    - Astronomy with full-sky CMB polarization survey
- Launch in early 2020s (LEO @ 600km, L2 option studied also)

### LiteBIRD working group

✤ 69 members (as of Oct. 1, 2013) International and interdisciplinary \*\* JAXA UC Berkelev Kavli IPMU **MPA** ATC/NAOJ **KEK** E. Komatsu Y. Chinone H. Fuke A. Ghribi N. Katayama K. Karatsu W. Holzapfel H. Nishino K. Hattori I. Kawano T. Noguchi Tohoku U. M. Hazumi (PI) H. Matsuhara A. Lee (US PI) Y. Sekimoto M. Hattori Yokohama NU. K. Mitsuda P. Richards M. Hasegawa Y. Uzawa K. Ishidoshiro S. Murayama T. Nishibori A. Suzuki Y. Hori K. Morishima S. Nakamura N. Kimura A. Noda **RIKEN** McGill U. K. Natsume K. Karatsu T. Matsumura S. Sakai Kinki U. M. Dobbs K. Koga H. Morii Y. Sato L Ohta Osaka Pref. U. R. Nagata K Shinozaki S. Mima K. Kimura **LBNL** S. Oguri H. Sugita C. Otani Saitama U. J. Borrill M. Kozu N. Sato Y. Takei M. Naruse H. Ogawa T. Suzuki T. Wada Tsukuba U. CMB experimenters N. Yamasaki O. Tajima M. Nagai (Berkeley, KEK, McGill, Eiichiro) T. Tomaru T. Yoshida X-ray astrophysicists H. Yamaguchi K. Yotsumoto M. Yoshida (AXA) Okayama U. **SOKENDAI** H. Ishino Infrared astronomers Y. Akiba A. Kibayashi (JAXA) Y. Inoue Y. Kibe 16/2 H. Ishitsuka Superconducting Device National Inst. H. Watanabe JAXA engineers, Mission Design (Berkeley, RIKEN, NAOJ, for Fusion Support Group, SE office Osaka U. Okayama, KEK etc.) Science S. Takakura S. Takada 9th East Asian Meeting on Astronomy, NCU, Taiwan (EAMA9) Masashi Hazumi (KEK) 2013/10/15

# **Cosmic inflation**

- An accelerating expansion at the very early universe.
- The leading hypothesis to answer one of the grand questions in cosmology "what powered the big bang ?"
- The most important prediction of inflation is generation of primordial gravitational waves.
- We can probe the inflationary gravitational waves with CMB polarization !
- Underlying quantum gravity theory, which is not yet understood, can also be tested by probing the inflationary universe.

So, how does it work ?

2013/10/15

9th East Asian Meeting on Astronomy, NCU, Taiwan (EAMA9) Masashi Hazumi (KEK)

of a second

INFLATION

last scattering

### Probing inflation with CMB polarization

Essence: CMB is an "experimental appratus" to record primordial gravitational waves



**CMB B-mode** 

### Sensitivities



#### LiteBIRD target sensitivity on r is x100 better than Planck

2013/10/15

### Comparison with laser interferometry

CMB polarization is much more sensitive.
Discovery of PGW from CMB polarization will set a clear target for future laser interferometry project(s).
a very strong science case can be made.





5



2013/10/15

## Roadmap

#### **POLARBEAR-2**

#### POLARBEAR







To be first MKID-based CMB polarization project MKID R&D w/ NAOJ, RIKEN, KEK, Okayama, Korea U.

### QUIET

2013/10/15

Ground-based projects as important steps
Verification of key technologies
Good scientific results
International projects

umi (KEK)

LiteBIRD

# POLARBEAR

International collaboration including KEK, Kavli IPMU, UCSD, UC Berkeley from Asia Pacific regions POLARBEAR-1 project led by UC Berkeley

- Search for inflationary B-modes to r=0.025 (95%C.L.) *and* detect gravitational lensing B-modes
- 3.5m primary mirror and large focal plane with 1274 TES bolometers
- First light in Chile in Jan. 2012 and large amount of data already recorded
- Roadmap:
  - 7588 TESes in 2014 (POLARBEAR-2)
    - r<0.01 (95%C.L.)
  - >22000 TESes in 2016(Simons Array)



9th East Asian Meeting on Astronomy, NCU, Taiwan (EANIA9)

## POLARBEAR-1 (First year of data)

E-mode polarization





2013/10/15

## Strategy

Synergy



Small Satellite for ultimate meas. of r ( $\delta$ r<0.001)

Super telescope array on ground 40 < I < 3000~10000

### **Powerful Duo**

# LiteBIRD project status/plan

- Selected as one of eight most important future projects by astronomy/astrophysics division of Science Council of Japan
- Recognized as one of key future JAXA missions in fundamental physics
- Japanese High Energy Physics (HEP) community has also identified CMB polarization measurements and dark energy survey as two important areas of their "cosmic frontier".
- To be ready for Mission Definition Review in 2014

2013/10/15

## Summary

- LiteBIRD will provide a decisive test for representative models of cosmic inflation.
- Precision CMB polarization full-sky survey will also provide lots of astronomical information.
- Roadmap includes powerful ground-based projects and detector R&D.
- Collaboration is seeking new members now ! (contact: masashi.hazumi@kek.jp)