QUIET Experiment

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Akito KUSAKA
(for QUIET collaboration)
University of Chicago, EFI and KICP
Outline

- What’s QUIET
  - Target
  - Collaboration
  - Site and Instrumentation
- Observing and analysis
- Future plan: QUIET phase-II
QUIET experiment
What is QUIET?

- Ground based
- CMB polarization
- Target: $l \sim 100$, primordial B-mode
- Phase-I: currently observing
- Phase-II: being proposed
QUIET collaboration

5 countries, 14 institutes, ~35 scientists

Observational Site Chajnantor Plateau, Chile
Collaboration meeting at Fermilab, June 2009
What QUIET aims for?

Phase-I: already as deep as Planck
Phase-II: x10 deeper than Planck

Map precision on 1x1 degree pixel:
- Planck: 1 μK (100 GHz)
- QUIET Phase-I: ~1 μK (40 GHz)
- QUIET Phase-II: 10^{-1} μK (90 GHz)
Where it is?

- Chajnantor Plateau, Chile
  - 5200 m
  - Extremely low moisture
  - ~1 hour drive from San Pedro de Atacama
  - Year-round access
  - Observing throughout the year (day and night)
QUIET Time Schedule

Development

Q-band observing

Q-band analysis

W-band observing

Phase-II

2008, October
Q-band (40GHz) observing start

2009, July
W-band (90GHz) observing start

2010
Already better than WMAP

Galaxy systematic effects not considered yet

WMAP 5 years
QUIET – What does it look like?

- Primary Mirror
- 2nd Mirror
- Focal Plane (Receiver)
- Platelet Array
- Electronics Box
- Primary Mirror
- Mount
What is great about QUIET?

- One of the world best polarimeter arrays
  - W-band (90GHz): 90 element, ~60μK s^{1/2}
  - Q-band (40GHz): 19 element, ~70μK s^{1/2}

- Unique HEMT amplifier technology
  - Frequency: 40GHz+90GHz (uniqueness in foreground treatment), +30GHz in phase-II
  - Different systematics from bolometer exps.
Key Technology: Polarimeter on Chip

“Polarimeter On Chip”
Key technology for large array (JPL)

c.f. CAPMAP polarimeter

L-R decomposition

OMT

HEMT Module

~3cm
~30cm
W-band Array

Array sensitivity

~60 $\mu$K$\sqrt{\text{s}}$

The world largest HEMT array polarimeter
Observing and Analysis
QUIET observing
In real world: data selection

Good weather

Extremely bad weather

Impossible to simulate the bad weather
Big effort required to guarantee the data quality
Null tests

- Divide data set into two subset.
  - Reasonable divisions (e.g., good/bad weather)
- Maps: $m_1$ and $m_2$
- “CMB power” for the map $m_1 - m_2$
- Heart of blind analysis
Expected result

- B-mode
  - Q-band close to world best.
  - W-band will be the world best

Q-band Monte Carlo simulation

Q-band (already collected)

W-band
(Near) Future
QUIET Phase-II (x16 scale up!)

Phase-I W-band 91-element array

499-element array (x3)
**Expected Sensitivity**

E-mode: High S/N measurement up to $\ell \sim 2000$

B-mode: Detection or significant limit on $r$, detection of lensing

$\Delta r \sim 0.018$

Lensing $\sim 35\sigma$ \(\rightarrow\) $\Sigma m_\nu < 0.3\text{eV}$
Summary

- **QUIET**
  - HEMT array polarimeter receiver: a unique choice of technology
  - Primary target is $l \sim 100$ primordial B-mode

- **Phase-I**
  - Q-band receiver has already collected $\sim 4000$ hours of data. Analysis in progress.
  - W-band data taking is continuing

- **Phase-II**
  - Factor $\sim 20$ scale-up of phase-I
  - Technology, Site, Observing: All proven at phase-I