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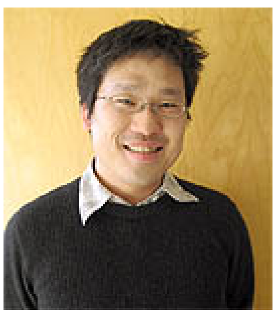
FAST BREAKING PAPERS - 2009

October 2009

PDF

Eiichiro Komatsu talks with *ScienceWatch.com* and answers a few questions about this month's Fast Breaking Paper in the field of Space Science. The author has also sent along an image of his work.



Article Title: FIVE-YEAR WILKINSON MICROWAVE ANISOTROPY PROBE OBSERVATIONS: COSMOLOGICAL INTERPRETATION
Authors: Komatsu, E;Dunkley, J;Nolta, MR;Bennett, CL;Gold, B;Hinshaw, G; Jarosik, N;Larson, D;Limon, M;Page, L;Spergel, DN;Halpern, M;Hill, RS; Kogut, A;Meyer, SS;Tucker, GS;Weiland, JL;Wollack, E;Wright, EL
Journal: ASTROPHYS J SUPPL SER, Volume: 180, Issue: 2, Page: 330-376, Year: FEB 2009
* Univ Texas Austin, Dept Astron, 2511 Speedway,RLM 15-306, Austin, TX 78712 USA.
* Univ Texas Austin, Dept Astron, Austin, TX 78712 USA.
* Princeton Univ, Dept Phys, Princeton, NJ 08544 USA.
(addresses have been truncated)

SW: Why do you think your paper is highly cited?

Cosmology is a very active field of research in science today. The observational data of temperature and polarization anisotropies of the cosmic microwave background radiation, obtained by the Wilkinson Microwave Anisotropy Probe (WMAP) mission, still maintains its position as a prime source of information for cosmologists, which include both astrophysicists and high-energy physicists.

This paper is one of seven papers describing the data, analysis method, systematic error limits, foreground emission, basic results, and cosmological interpretation of the latest WMAP five-year observations. Demands and appetite for better data and some observational guidance as to which directions to take next are always very high in the area of cosmology. I think that such high demands from the cosmology community are reflected in the citation counts.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

This paper describes the cosmological interpretation of the new WMAP five-year results, in combination with the latest measurements of cosmological distances of other astrophysical sources.

SW: Would you summarize the significance of your paper in layman's terms?

Our previous papers on the cosmological interpretations of the cosmic microwave background data from the WMAP one-year and three-year observations, as well as other papers on the large-scale structure of the Universe and supernovae, have established the standard cosmological model; however, this is a very strange model.

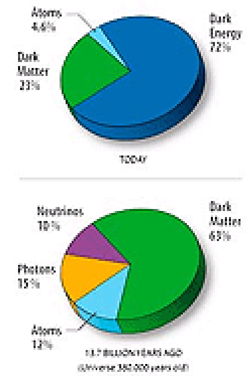
According to this model, more than 70% of energy in the present-day Universe is made by "dark energy," an unknown form of energy which can cause a repulsive force to accelerate the expansion of the Universe.

While this model is a simple model that has merely six parameters, there are a lot of unknowns hidden in this phenomenological model: for example, the nature of dark energy and the nature of dark matter that we know very little about. Therefore, in this paper, we tried to find evidence for any deviations from this simple, six-parameter cosmological model.

Despite the unprecedented precision that the five-year WMAP data has achieved, we could not find any compelling deviations from the simplest model. This is rather remarkable. The spatial geometry of the Universe appears to be quite flat—deviation from flat geometry is now constrained to be less than 1%.

The observed temperature anisotropy seems to obey Gaussian statistics to high precision— the deviation, called "non-Gaussianity," is less than 0.1%. The nature of dark energy is consistent with a mystical "cosmological constant" at the level of 10%.

Figure 1 [+] details



Cosmic Pie Chart: This chart shows...

Parity (mirror) symmetry seems respected on the cosmological scales. We have not seen evidence for the primordial gravitational waves from the ultra early universe called the era of cosmic inflation—and other things. The simplest model is full of mystery, but it still remains as the best phenomenological description of the Universe that fits the data.

SW: How did you become involved in this research, and were there any problems along the way?

I came to Princeton University as a visiting graduate student from Japan in 1999, hoping to get involved with the WMAP team. Fortunately, my dream has come true! I would like to thank the PI (Charles Bennett (see also | see also), Johns Hopkins University) and Co-PIs of the WMAP mission, especially my thesis advisor, David Spergel, for letting me join the team.

Working on the WMAP data with the team members over the last eight years has been a fantastic experience. The amount of work was tremendous, and of course there were many, many difficulties in getting things done correctly, but all of them were worthwhile.

WMAP's major achievement was to produce high-quality maps of temperature and polarization anisotropies of the cosmic microwave background, and to constrain the physical properties of the Universe with the unprecedented precision and accuracy. To achieve this, many factors had to be kept under control at the level of 1%, or even at the level of 0.1%. One thing that we struggled to understand was the noise properties of the polarization data—various null tests kept failing and it took us quite a while to figure out what was going on.

SW: Where do you see your research leading in the future?

I have four items on my agenda. To understand: (i) the nature of dark energy, (ii) the nature of dark matter, (iii) the physics of cosmic inflation, and (iv) the emergence and evolution of structures in the Universe. The WMAP has made a tremendous contribution to advancing our knowledge on these fundamental questions, and I would like to contribute to making further, hopefully significant, progress on them.

Both better theoretical understanding of the physics and better observational data are needed to make progress on any of these items. I am involved in the University of Texas at Austin and its partner's "Hobby-Eberly Telescope Dark Energy Experiment (HETDEX)—a next-generation galaxy survey that can address all of the above items.

I am excited about the prospect of this experiment. I am also quite excited about the founding of the Texas Cosmology Center (TCC) at the University of Texas at Austin, which was established to foster close collaborations between high-energy physicists and astrophysicists on the above problems in cosmology.

SW: Do you foresee any social or political implications for your research?

Whenever I give public lectures on cosmology, I always get the following question, "What is your research good for?" My answer would be, "It depends." If you have ever looked up the night sky and wondered anything about the Universe, we can offer you a lot of answers to most of the questions you might have about the Universe. Some of the answers, which were derived from scientific observations and experiments, are probably beyond the wildest imagination.

Questions about the Universe are ultimately related to questions about the origin of ourselves. In that sense, cosmology has social implications for how we think about ourselves. On the other hand, if you have never looked up the night sky and never cared anything about the Universe before, never mind, and leave us alone!

Eiichiro Komatsu
Director
Texas Cosmology Center
Associate Professor
Department of Astronomy
The University of Texas at Austin
Austin, TX, USA
Web

Figure 1:

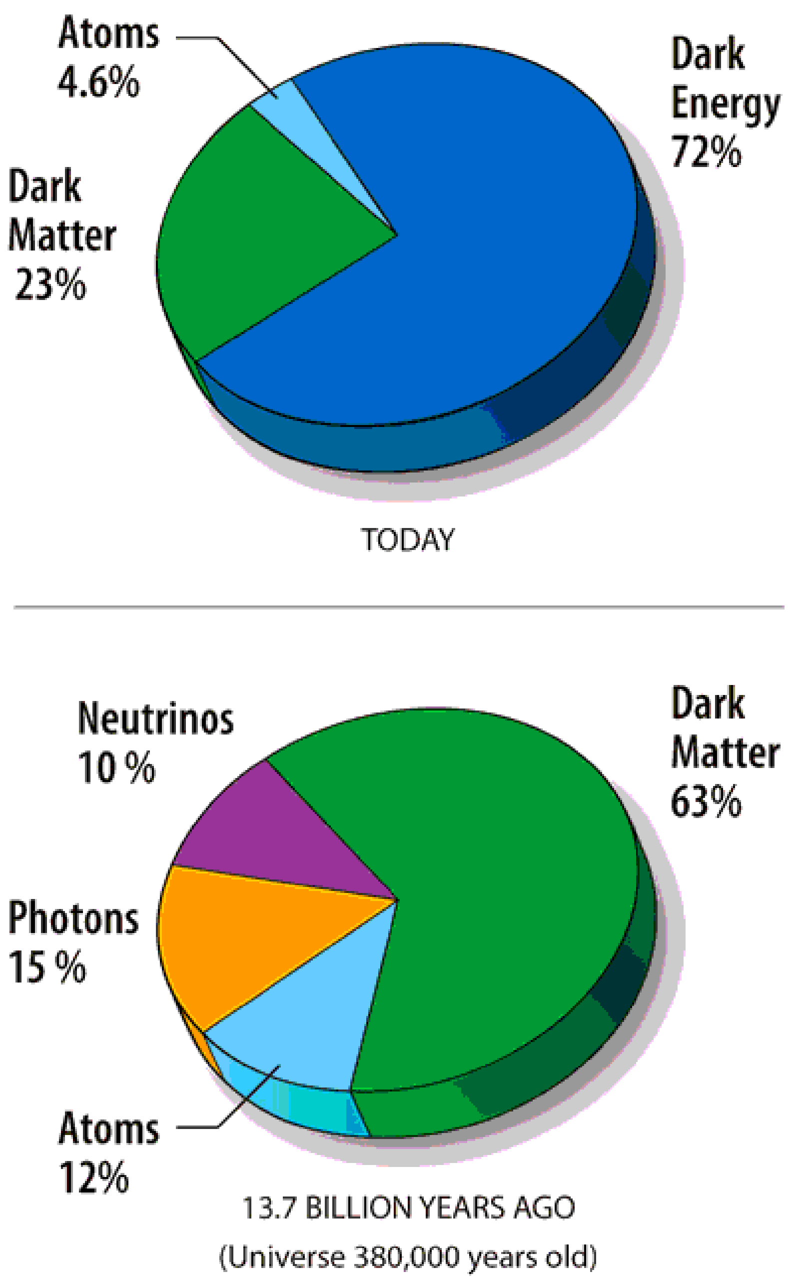


Figure 1:

Cosmic Pie Chart: This chart shows that the energy density of the Universe today is mostly dominated by mysterious "dark energy" and "dark matter," and the ordinary matter such as atoms makes up only 4.6%.

When the Universe was very young—as young as 380,000 years old—there were significant contributions also from photons and neutrinos to the energy density of the Universe.

KEYWORDS: COSMIC MICROWAVE BACKGROUND; COSMOLOGY: OBSERVATIONS; DARK MATTER; EARLY UNIVERSE; INSTRUMENTATION: DETECTORS; SPACE VEHICLES: INSTRUMENTS; TELESCOPES.

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2009 : October 2009 - Fast Breaking Papers : Eiichiro Komatsu on Energy Density of the Universe