Jonathan White

3rd year PhD student, Cosmology group, YITP



- Brought up in the Lake District, England
- Undergraduate studies at the University of Oxford
- A year of work in a start-up company (working with my old professor)
- Masters course at Imperial College London









- Brought up in the Lake District, England
- Undergraduate studies at the University of Oxford
- A year of work in a start-up company (working with my old professor)
- Masters course at Imperial College London





- Brought up in the Lake District, England
- Undergraduate studies at the University of Oxford
- A year of work in a start-up company (working with my old professor)
- Masters course at Imperial College London





- Brought up in the Lake District, England
- Undergraduate studies at the University of Oxford
- A year of work in a start-up company (working with my old professor)
- Masters course at Imperial College London





Why Japan?

- Developed a personal interest in Japan after making friends with international students from Japan at university
- Was also aware that the research community is very much an international one. Advances in both experimental and theoretical physics require the collaboration of experts all over the world, e.g. Kamiokande and K2K here in Japan
- Professor Sasaki (my supervisor) is one of the pioneers of cosmological perturbation theory, and has strong ties with UK research groups



Why Japan?

- Developed a personal interest in Japan after making friends with international students from Japan at university
- Was also aware that the research community is very much an international one. Advances in both experimental and theoretical physics require the collaboration of experts all over the world, e.g. Kamiokande and K2K here in Japan
- Professor Sasaki (my supervisor) is one of the pioneers of cosmological perturbation theory, and has strong ties with UK research groups



Why Japan?

- Developed a personal interest in Japan after making friends with international students from Japan at university
- Was also aware that the research community is very much an international one. Advances in both experimental and theoretical physics require the collaboration of experts all over the world, e.g. Kamiokande and K2K here in Japan
- Professor Sasaki (my supervisor) is one of the pioneers of cosmological perturbation theory, and has strong ties with UK research groups



Progress of Theoretical Physics Supplement No. 78, 1984

Cosmological Perturbation Theory

Hideo KODAMA and Misao SASAKI*

Department of Physics, University of Tokyo, Tokyo 113 *Department of Physics, Kyoto University, Kyoto 606













If we look to the sky, we can see the radiation that has been travelling towards us since the epoch of recombination - the CMB (cosmic microwave background)



If we look to the sky, we can see the radiation that has been travelling towards us since the epoch of recombination - the CMB (cosmic microwave background)





If we look to the sky, we can see the radiation that has been travelling towards us since the epoch of recombination - the CMB (cosmic microwave background)





Fluctuations due to quantum fluctuations in inflation.

If we look to the sky, we can see the radiation that has been travelling towards us since the epoch of recombination - the CMB (cosmic microwave background)





- Fluctuations due to quantum fluctuations in inflation.
- Can use these fluctuations to probe inflationary physics, which is at $E \sim 10^{13}$ Gev!

If we look to the sky, we can see the radiation that has been travelling towards us since the epoch of recombination - the CMB (cosmic microwave background)





- Fluctuations due to quantum fluctuations in inflation.
- Can use these fluctuations to probe inflationary physics, which is at $E \sim 10^{13}$ Gev!

"The Universe is the poor man's particle accelerator"

After arriving in Japan in October 2010 I took a 5-month language course. My level is still very basic, but it has allowed me to



After arriving in Japan in October 2010 I took a 5-month language course. My level is still very basic, but it has allowed me to

• Cope with daily life outside of university, such as renting an apartment, getting around on public transport etc



After arriving in Japan in October 2010 I took a 5-month language course. My level is still very basic, but it has allowed me to

- Cope with daily life outside of university, such as renting an apartment, getting around on public transport etc
- Make friends outside of university, where not everyone speaks English



After arriving in Japan in October 2010 I took a 5-month language course. My level is still very basic, but it has allowed me to

- Cope with daily life outside of university, such as renting an apartment, getting around on public transport etc
- Make friends outside of university, where not everyone speaks English
- Feel more a part of my research group, being able to socialise outside office hours



Being able to speak English opens up so many opportunities, both personal and academic.

Being able to speak English opens up so many opportunities, both personal and academic.

Advice from my experience of learning Japanese:

• **Don't hesitate to try** and speak. People always seem happy when I try, even if what I say is far from perfect, and I think we learn from our mistakes.

Being able to speak English opens up so many opportunities, both personal and academic.

Advice from my experience of learning Japanese:

- **Don't hesitate to try** and speak. People always seem happy when I try, even if what I say is far from perfect, and I think we learn from our mistakes.
- Take any opportunity to use English. It's easy at a university like Kyoto clubs, circles, international students etc

Being able to speak English opens up so many opportunities, both personal and academic.

Advice from my experience of learning Japanese:

- **Don't hesitate to try** and speak. People always seem happy when I try, even if what I say is far from perfect, and I think we learn from our mistakes.
- Take any opportunity to use English. It's easy at a university like Kyoto clubs, circles, international students etc
- It's not just about study. Enjoy making international friends, watching movies etc. Learning a new language then follows naturally.





Please feel free to contact me at any time with any questions, or just to chat!

jwhite@yukawa.kyoto-u.ac.jp

• In the Big Bang model of the universe, the universe at earlier times is much hotter and electrons are not bound to nuclei. We therefore have very frequent Compton scattering of photons off electrons.

- In the Big Bang model of the universe, the universe at earlier times is much hotter and electrons are not bound to nuclei. We therefore have very frequent Compton scattering of photons off electrons.
- At some point, the universe cools to the extent that electrons become bound to protons, meaning that the scattering of photons becomes very rare. This epoch of "recombination" defines the surface of last scattering, after which photons travel freely

- In the Big Bang model of the universe, the universe at earlier times is much hotter and electrons are not bound to nuclei. We therefore have very frequent Compton scattering of photons off electrons.
- At some point, the universe cools to the extent that electrons become bound to protons, meaning that the scattering of photons becomes very rare. This epoch of "recombination" defines the surface of last scattering, after which photons travel freely
- If we look to the sky, we can see these photons that have been travelling towards us since the epoch of "recombination" the CMB

- In the Big Bang model of the universe, the universe at earlier times is much hotter and electrons are not bound to nuclei. We therefore have very frequent Compton scattering of photons off electrons.
- At some point, the universe cools to the extent that electrons become bound to protons, meaning that the scattering of photons becomes very rare. This epoch of "recombination" defines the surface of last scattering, after which photons travel freely
- If we look to the sky, we can see these photons that have been travelling towards us since the epoch of "recombination" the CMB



 Nasa's COBE satellite determined a very uniform temperature distribution across the sky! T = 2.728 K

• But the maximum distance that light could have travelled up to the time of "recombination" is relatively small, so we don't expect causally disconnected regions of the universe to have been at the same temperature.

- But the maximum distance that light could have travelled up to the time of "recombination" is relatively small, so we don't expect causally disconnected regions of the universe to have been at the same temperature.
- Inflation helps to solve this problem if the universe undergoes accelerated expansion before recombination, then causally connected regions can be expanded to sizes larger than the observable universe

- But the maximum distance that light could have travelled up to the time of "recombination" is relatively small, so we don't expect causally disconnected regions of the universe to have been at the same temperature.
- Inflation helps to solve this problem if the universe undergoes accelerated expansion before recombination, then causally connected regions can be expanded to sizes larger than the observable universe
- What is the physics driving inflation? Looking a bit closer, there are temperature fluctuations ~ 10⁻⁵. We try to constrain a variety of inflationary models by comparing the fluctuations they predict with those observed

