

FLASS Distinguished Seminar: God, Science and the Beginning of Time

Date: 19 June 2023 (Monday)

Time: 2:30 pm – 4:00 pm

Venue: B4-LP-06, Tai Po Campus, EdUHK

Language: English

Speaker: Dr Luke BARNES (PhD in Astronomy, University of Cambridge)

Abstract:

We see order and complexity in the universe around us: planets, nebulae, stars, galaxies and more. Cosmology and astrophysics have pieced together the process by which this structure formed from simple beginnings, under the action of the laws of nature. But the infamous "second law of thermodynamics" says that the universe is winding down, moving from order to chaos. How do these ideas fit together? And what does this tell us about our universe, and our place in it?

Summary of the Talk:

Starting the talk with the irreversible change from water to ice in room temperature, Dr Barnes explained that some physical processes are **reversible** (e.g. pendulum swinging) and some are **irreversible** (e.g. ice melting). Matter spreads, energy spreads, reducing the quality of things. According to the Second law of Thermodynamics, things naturally move from order to disorder, from a higher quality to a lower quality, from a more useful state to a less useful state. The total amount of **useful** energy never increases, and often decreases. Irreversible processes cause the amount of useful energy decrease, e.g. ice melts. Useful energy means rare arrangement while useless energy means common arrangement, thus arrangement always turns from rare to common.

Useful states are ordered states, which are very rare and so almost always evolve into disordered, more probable states. Disordered, more probable states tend to evolve into disordered, more probable states.

Concerning the following terms: "**Complexity and Order**", Order is about **arrangements** and Complexity is about **description**. Disorderly states are usually macroscopically simple while orderly states can be simple or complex. Dr Barnes used an animation of injecting blue ink into a tank of clear water to explain this. Macroscopic processes consist of large numbers of **microscopic** processes which are almost **reversible**. But there is a puzzle that some **macroscopic** processes are **irreversible**.

Given any orderly state, the amount of order at some other time is almost certainly lower. This works beautifully into the future, but is in violent conflict with our memories of the past (the order of the universe). We need more than time-symmetric laws to explain our time-asymmetric universe. We can explain the second law, and vindicate our memories, by proposing that universe began in very orderly state. This is called **the past hypothesis**. (The past hypothesis is a fundamental law of physics that postulates that the universe started in a low-entropy state, in accordance with the second law of thermodynamics.)

Dr Barnes further explained that we can trace the order in our universe back to its "**smooth hydrogen**" beginning, with plenty of useful energy. Could there be an even earlier state that explains how our universe can be smooth? Before the smooth matter in expanding state, a less orderly state is against the second law. If it is a fluctuation state, it will jump to our universe now we observe, passing over the smooth matter in expanding state. The most possible conclusion is that it must be an **even more** orderly state at the very beginning. The big question is that the universe simply could not come from chaos to order. Every successful scientific explanation of some fact about the universe today assumes an orderly past. Laws are only part of the story.