A Direct Glimpse into Cosmic Dawn

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Why this is important

The origin story of how our Universe came to be is substantially incomplete, but the next few years will fill in a crucial part of our cosmic timeline—the era of Cosmic Dawn, when the first stars and galaxies formed.

Ugh. Spikes. All over the place. I'm in my office, staring at my computer screen. We're looking at data fresh from a night's worth of observations using our radio telescopes in the South African Desert. We were looking forward to a good morning's worth of data analysis, admiring the smooth undulating patterns that we've come to associate with the Milky Way Galaxy. Instead, the spikes we see are indicative of someone operating a radio transmitter—illegally.

The hunt for the culprit begins. We message our international collaborators, giving them the few clues that we have: the rough time when this happened, and any location- and radio frequency-information that we've gleaned from our crummy data. They'll investigate the cause, with our team on the ground possibly even driving out on their diesel jeeps to look for the source of the transmission. (Not gasoline—those vehicles produce their own radio pollution). As for us, all we can do is wait.

The HERA telescope array in South Africa. The array is a large grid of 14 meter (42 ft) diameter non-tracking dishes packed into a hexagonal grid 300 m (900ft) across.(Images courtesy of the HERA Collaboration.)

But we won't have to wait long, for this is an incredibly exciting time for the Hydrogen Epoch of Reionization Array (HERA). HERA (pictured at left) is a radio telescope being built in the South African Karoo Desert. When construction is complete, HERA will consist of 350 radio dishes operating in concert as one giant supertelescope that is about a mile across. the frequency range and sensitivity of HERA is custom-designed to detect faint---and ancient---radio waves emitted by hydrogen atoms. These waves were emitted during an epoch known as Cosmic Dawn, when the first stars and galaxies were formed. This was a crucial moment in our Universe's history, but It has never been directly observed. HERA will change this.

The next year will be an exciting time for HERA researchers at McGill. We are currently preparing the first HERA upper limits on the strength of the aforementioned radio signal from the early Universe. Within the next year or two, these upper limits will significantly impact our understanding of the environment in which the first galaxies formed. For instance, we will place constraints on the temperature of the intergalactic medium during that epoch, slowly building up a complete picture of what our Universe was like during Cosmic Dawn: what were the first galaxies like? Were they like the galaxies we see today, or were they substantially different? Did they emit strongly in ultraviolet? In X-rays? How many of these galaxies were there, and how many of them were large galaxies? What role did dark matter play in all of this? At McGill, we not only have front-row seats on this journey; as a full partner institution of HERA, we play a crucial part in this exciting quest to complete our understanding of Cosmic Dawn.