Into the Dark Ages

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The Dark Ages Radio Explorer (DARE) will use the highly-redshifted hyperfine 21-cm transition from neutral hydrogen to track the formation of the first stars, black holes, and galaxies by their impact on the intergalactic medium during the end of the Dark Ages and during Cosmic Dawn (redshifts 11–35). DARE will measure the sky-averaged spin temperature of neutral hydrogen at the unexplored epoch 80-420 million years after the Big Bang, providing the first evidence of the earliest objects to illuminate the cosmos and testing our models of galaxy formation. DARE’s science objectives include:

* When did the first stars form?
* When did the first accreting black holes form?
* When did the Hot Bubble Dominated Epoch and Reionization begin?
* What surprises does the end of the *Dark Ages* hold?

DARE will answer two fundamental questions identified in the recent Decadal Survey, *New Worlds, New Horizons in Astronomy and Astrophysics:* What were the first objects to light up the Universe, and when did they do it? The birth of the first stars and black holes is one of the truly transformative events in the history of the Universe. DARE’s approach is to measure the spectral shape of the sky-averaged redshifted 21-cm signal from neutral hydrogen over the redshift range 11-35, corresponding to radio frequencies 40-120 MHz.

These observations are challenging because the 21-cm signal strength is predicted to be much fainter than various foregrounds. However, DARE eliminates the most intense foreground, namely human-generated radio frequency interference (RFI). DARE orbits the Moon for a baseline mission of 3 years and takes data above the lunar farside, the only location in the inner solar system proven to be free of RFI. The smooth frequency response and differential radiometry of DARE are effective in removing the remaining foregrounds (i.e., the Galaxy and solar system objects).