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Theoretical Models of Reionization

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The cosmic reionization of hydrogen in the intergalactic medium is a milestone event in the history of structure formation that strongly impacts later stages of galaxy formation. Recent data indicate that it occurred at $z \sim 6-10$. This era will be probed by a range of instruments in the next several years, including near-infrared telescopes, CMB telescopes, and low-frequency radio arrays. We will review our theoretical expectations of this process and describe how it can be used to constrain the properties of the first galaxies and quasars. In the initial stages, reionization is driven by the clustering of luminous sources. Toward the end, inhomogeneous recombinations in the cosmic web take over. Future progress in understanding the process will come from a mix of analytic modeling and numerical simulations. We will also compare the reionization of helium, due to quasars at $z \sim 3$, to that of hydrogen and show how it can illuminate the higher-redshift event.