New Method to predict the Cosmic Dawn Signal

together with: Sambit Giri, Timothee Schaeffer

Aurel Schneider, University of Zurich
SKA at a glance

The diagram shows a progression from low frequency (z = 25) to high frequency (0) along a timeline. The image represents a scientific visualization from Thomas et al.
SKA at a glance

Cosmic Dawn

Reionization

Galaxies

Intensity Mapping

z = 25 → 10 → 5 → 0

Thomas et al

Villaescusa-Navarro
Cosmic Dawn

Reionization

Cosmic Dawn
Cosmic Dawn

- Cosmic Dawn
  - Reionization
    - Analytical
  - Semi-numerical
  - Radiation-hydro sims
  - N-body plus 1d RT
  - N-body plus full RT

They might all be used! (see methods for other cosmological observables)
Halo (Source) Model at Cosmic Dawn

\[ P_{XY}^{1h} \propto \int dM \frac{dn}{dM} (f_* M)^2 u_X u_Y \]
\[ P_{XY}^{2h} \propto P_{\text{lin}} \int dM \frac{dn}{dM} f_* M u_X b_X \int dM \frac{dn}{dM} f_* M u_Y b_Y \]

\[ P_{XY}(k) = P_{XY}^{1h} + P_{XY}^{2h} \]
Halo (Source) Model at Cosmic Dawn

\[
P_{XY}^{1h} \propto \int dM \left( \frac{dn}{dM} \right) \left( f_* M \right)^2 u_X u_Y
\]

\[
P_{XY}^{2h} \propto P_{\text{lin}} \int dM \left( \frac{dn}{dM} \right) f_* M u_X b_X \int dM \left( \frac{dn}{dM} \right) f_* M u_Y b_Y
\]

\[
P_{XY}(k) = P_{XY}^{1h} + P_{XY}^{2h}
\]

AS (2018)
Halo Model at Cosmic Dawn

\[ P_{XY}^{1h} \propto \int dM \frac{dn}{dM} (f_\ast M)^2 u_X u_Y \]

\[ P_{XY}^{2h} \propto P_{\text{lin}} \int dM \frac{dn}{dM} f_\ast M u_X b_X \int dM \frac{dn}{dM} f_\ast M u_Y b_Y \]

\[ P_{XY}(k) = P_{XY}^{1h} + P_{XY}^{2h} \]
Halo Model at Cosmic Dawn

\[ \rho_Y(r) \propto \frac{1}{4\pi r^2} \dot{M}_{\text{acc}} \]

\[ z = z(r) \]

\[ P_{XY}^{1h} \propto \int dM \frac{d^2n}{dM} (f_*M)^2 u_X u_Y \]

\[ P_{XY}^{2h} \propto P_{\text{lin}} \int dM \frac{d^2n}{dM} f_*M u_X b_X \int dM \frac{d^2n}{dM} f_*M u_Y b_Y \]

\[ P_{XY}(k) = P_{XY}^{1h} + P_{XY}^{2h} \]
Results ...
Results ...
Results ... and comparison with 21cmFAST (---)
Application to current upper limits (HERA)
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First (simplistic) 4-parameter model
Forecasting the future (SKA)

... the case of mixed dark matter
Forecasting the future (SKA)

... the case of mixed dark matter
Forecasting the future (SKA)

... the case of mixed dark matter
Further steps …

… extensions to include reionisation

… calculate bi-spectrum

… scan the full model parameter space

… forecasts for SKA

Aurel Schneider, University of Zurich