Suggested Outline

* **Foreword** – brief description highlighting the topical nature of the redshifted 21-cm line and its ability to transform how we see and understand our Universe over the next few years. Contributors: *Andrei Mesinger*
* **Theoretical framework** – a basic background of the physics of the 21-cm line, placing it in a cosmological context. Subtopics could include: a radiative transfer derivation of the 21-cm brightness temperature offset from the CMB, and a summary of quantum mechanical processes determining the gas spin temperature. Contributors: *Steven Furlanetto*
* **The astrophysics of the first galaxies from the 21-cm line** – a discussion highlighting how the soft- UV, ionizing UV, and X-ray properties of the first galaxies are encoded in the patterns and timings of the 21-cm signal. Subtopics could include: the evolution of the IGM ionization and temperature, a discussion of the corresponding sources and sinks, a qualitative discussion how global and interferometric signals can discriminate between different source models, challenges in modelling the cosmic signal and a summary of the available simulation tools. Contributors: *Jordan Mirocha*
* **Physical cosmology from the 21-cm line** – a discussion of using 21-cm intensity mapping/interferometry to constrain the matter power spectrum and cosmological parameters. The signal can also be used as a signpost for new physics beyond the standard model, such as heating and cooling of the primordial gas through interactions with dark matter. Subtopics could include: redshift space distortions and their likely observability, measuring the matter power spectrum during the cosmic dawn and (eventually) the dark ages, IGM heating through dark matter annihilations, IGM cooling through interactions with exotic dark matter candidates.
* **Inference** – How do we learn about astrophysics and cosmology from the 21-cm signal? What is the optimal statistic for extracting astrophysical and cosmological parameters? Subtopics could include: parametrizing our unknowns, Bayesian inference in the context of 21-cm, Monte Carlo Markov Chain approaches, power spectrum emulators, inference from power spectra using neutral networks, non-Gaussian statistics, inference from images using convolutional neural networks. Contributors: *Bradley Greig*
* **21-cm observations: basic framework, power spectra and images** – basic intro to radio interferometry, visibility, beam forming, etc. It would include a discussion of the issues associated in producing the relevant data products. How does calibration and instrument design depend on the desired data? Subtopics could include: from visibilities to power spectra, maximum vs minimum redundancy in array design, baseline coverage and foreground separation, the choice of element field of view, calibratability and ionosphere. Contributors: *Gianni Bernardi*
* **Foregrounds** – a discussion of the main expected foregrounds and how these can be best characterized. The benefits and drawbacks of different foreground mitigation strategies will be discussed. Subtopics could include: overview of physical and statistical properties of foregrounds, polarization leakage, foreground avoidance and subtraction. Contributors: *Emma Chapman and Vibor Jelic*
* **Status of global 21-cm experiments** – current challenges and progress of the all-sky experiments. Subtopics could include: a historical perspective on global experiments, brief summary of current experiments and their status, how global experiments complement interferometric ones, a balanced discussion of the recent EDGES result, as well as an outlook for future confirmation of this result. Contributor: *Lincoln Greenhill and Ravi Subrahmanyan*
* **Status of interferometric 21-cm experiments** – current challenges and progress of interferometry telescopes, including upper limits and forecasts. Subtopics could include: a historical perspective, summary of each experiment’s status and particular approach to a detection, forecasts for eventual detections. Contributors: *Cathryn Trott* *and Jonathan Pober*
* **Future prospects** – although we do not have an unambiguous detection yet, it would be irresponsible not to plan for future telescopes, given the transformative potential of the 21-cm signal. This section will outline future directions, from telescopes currently being built like HERA and then SKA, to futuristic missions. The later include dark side of the moon experiments and space-based 21-cm interferometers, which have the potential to measure matter fluctuations well into the Dark Ages. Contributors: *Leon Koopmans* and *Gianni Bernardi*