lenses, as high-redshift objects traverse a longer path through the universe and are thus more likely to be lensed. The integral source count is likely to be very steep in the submillimetre, giving a large magnification bias and resulting in a much higher lens fraction for even modest lens magnifications *[Blain, 1996, 1997]. Blain [1996]* shows that for some models, lensed sources could even be in the majority for some ranges of 850-μm flux. He also discusses optimum strategies for finding large numbers of gravitational lenses with instruments such as ALMA, despite its small ($\sim 15''$) field of view. In principle it should be possible to find ~100 lenses in an observing time of about 2 weeks, although whether this is better done with a few deep pointings or a wider, more shallow survey depends on how the density and luminosity of star-forming galaxies evolve with redshift.

The likely large number of lenses to be found with next-generation submillimetre instruments has implications for cosmology. *Blain [1998]* has shown that a relatively small lensing survey could distinguish sensitively between cosmological models, as lensing rates for sources of 850-μm fluxes between 1 mJy and 100 mJy differ by factors of 3-5 for plausible cosmologies and the large lensing fraction implies a small Poisson error on the statistics. A major problem is the systematic error involved in understanding the evolution of the lensing galaxies which boost the flux of the background submillimetre sources. A still more difficult problem is likely to be encountered in the determination of the luminosity function of the parent population. For this, redshifts of samples of sources with $S_{850\mu m}$ ~2 mJy will need to be obtained. This is not easy; many such sources are optically very faint *[Smail, Ivison & Blain, 1997]* and it has proved extraordinarily difficult to obtain complete redshift information for much less extreme sources *[Marlow et al., 2000*; *McKean et al., 2001]*.

6.2 The Square Kilometre Array

The design goals of the SKA call for sensitivities approaching 100 times that of the VLA, operation at frequencies up to at least 5 GHz, and superb imaging capability at resolutions < 0.03 arcsec at 5 GHz (for an up-to-date description of the SKA project see http://www.ras.ucalgary.ca/SKA/). One can assume, therefore, that with a search methodology similar to that adopted for JVAS/CLASS (and outlined in section 2.2) many thousands of galaxy-mass lenses could be identified from their radio structures alone. In the next section we outline how one might use this two-orders-of-magnitude larger sample to carry out new astrophysical investigations on galaxies and their cosmological evolution.

The enormous sensitivity and superlative imaging capability of the SKA also allows other important lensing investigations on individual systems, which have been touched on in previous sections, to come to full maturity. For example faint extended structures, currently unseen, will almost certainly be detected by the SKA in most lensed images and these will provide powerful constraints on mass distributions on kpc-scales. In addition it is highly likely that the SKA will detect the central ("odd") images in most systems providing a direct measure of the mass concentration within the central few parsecs. Other fascinating possibilities open to an instrument with the SKA's sensitivity involve observations in redshifted HI. As mentioned in section 5 the velocity distribution in the lensing galaxy can be directly studied using the lensed continuum emission from the background object simply as a distributed light source; the hydrogen in front of the extended lensed images can then be probed by imaging in absorbed HI. If, on the other hand, an

HI-rich, and by implication extended, background galaxy is itself lensed then the additional spatially-dependent velocity structure of the background galaxy provides a large amount of additional information about the system. If the system is imaged in narrow spectral channels a detailed picture of both the mass distribution in the lens and the HI distribution in the background galaxy can be reconstructed.

The SKA will also have a major impact on cosmology via the technique of weak gravitational lensing. For large impact parameters the projected mass distribution only weakly distorts the faint background galaxies but from the observed distortion pattern one can directly calculate the projected mass surface density, up to some additive constant, (e.g. *Squires & Kaiser [1996]*). The technique depends on having a high surface number density of background objects and so far, most weak lensing studies have been undertaken with ground–based optical telescopes (see e.g. *Bacon et al. [2000]* for a recent example) although studies have been painstakingly made using multiple pointings with HST (e.g. of the cluster CL 1358+62; *Hoekstra et al. [1998]*). The HST's small point spread function (psf) is a major advantage over ground based observations. To recover the lensing signal one needs to correct for the effect of seeing and for objects with sizes comparable to the seeing psf (most faint galaxies), these corrections become very large, amplifying the uncertainty in the ellipticity due to photon noise. The SKA will offer many advantages for weak lensing studies: first, radio source densities similar to those in the Hubble Deep Field can easily be reached; most of these sources will be the same normal galaxies visible to the HST; secondly its psf will be <0.1 arcsec and extremely well-defined; thirdly the SKA's field-of-view will be large, about one square degree; this is sufficient to probe scales of some 20 Mpc on a side (at $z = 0.3$) per pointing. The SKA will therefore provide clean measurements of cluster mass surface densities as well as routine detection of the weak lensing signature due to large-scale structure. A review of the potential impact of the SKA on weak lensing is given by *Schneider [1999]*.

6.3 The future, or: what do we do with a thousand lenses?

There seems little doubt that the next decade will bring surveys which discover lenses not singly, but in battalions of a thousand or more. The obvious advantage of such an advance is an improvement in the random errors in determinations which rely on lens statistics, such as the measurement of Ω_Λ. Although by then both CMB measurements, such as that envisaged for the Planck satellite, and supernova searches should have yielded values for most cosmological parameters, experience has shown that an independent determination is always of value. The CMB experiments will also provide powerful constraints on H_0, but even here a second line of attack is highly desirable.

After the cosmological parameters have been determined, a sample of 1000 gravitational lenses will come into its own as a unique probe of mass distributions of galaxies across the range of luminosity, redshift and Hubble type. The classical method for determining the mass distribution of a galaxy is to find a kinematic tracer such as globular clusters and planetary nebulae and perform spectroscopy and detailed modelling to determine the velocity field and hence the distribution of mass. This is not a trivial process; only a handful of galaxies such as the Milky Way, M31 and M33 have been seriously tackled in this way. To do this at redshifts of 0.5 is beyond the reach even of 40-m class optical telescopes. By contrast, gravitational lensing is already beginning to give some indications of mass distributions at this redshift, though even with 63 galaxy-mass lenses, problems of small-sample statistics bedevil the subject. The major problem is that only very few lenses (about 5-10%) have sufficient observational constraints to allow very detailed model fitting. A large number of lenses will give a significant number of well-constrained mass models for each Hubble type and for a range of luminosities. And the ultimate prize is to be able to trace galaxy evolution; how galaxies form, merge and accrete matter during the entire history of the observable universe.

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