# OPTICAL INTERFEROMETRY: SUMMARY AND PERSPECTIVES

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The outstanding progress of radio astronomical interferometric imaging - a gain in angular resolution of $10^{10}$ in 50 years - demonstrates that once basic physical principles are established and technology developed, the field can develop with immense benefits for astronomy. Today, physics and technology give solid foundations for rapid growth of optical interferometry.

In a graph of angular resolution vs. wavelength there is a large empty domain. This "ecological niche" (Ekers) contains fundamental astrophysical phenomena where the combination of physical sizes, distances and temperatures places objects such as forming stars and planets, galactic nuclei and observable motions on the scale of years (e.g. masers or jets from AGNs). Optical interferometry in the visible and infrared will fill most of this "niche", leaving only the 300 nm and the 20-500 $\mu$m ranges for future space ventures.

Optical interferometry sometimes appears strange to classical optical astronomers, while it is increasingly achieving a common language with radioastronomers. This allows the new field to draw from the considerable expertise of the mature one. But the hope of considering an optical interferometer as a "black box" producing images is still in the distant future.

The phase perturbations due to the Earth's atmosphere are largely understood, although the value of the outer scale of turbulence seems to vary from meters to km depending on site, while millimetric results indicate $H_2O$ fluctuations extending to km scale. Optical interferometry is heading towards complete internal phase control of the instrument (Berkeley, Mt. Wilson) using servo-loops, and for tracking of external atmospheric errors (CERGA). On single dishes, adaptive optics (ESO, NOAO) may fully control the phases and make speckle interferometry obsolete on the new generation of optical telescopes, at least in the infrared. Conversely, large dishes operated at mm wavelengths encounter multispeckle images, a nuisance only bound to grow with the advent of multi pixel mm detectors.

Isoplanatic limitations are encountered through ionospheric phase drifts on metric telescopes (Swarup) and tropospheric index fluctuations in the optical: this deserves systematic studies for the future of adaptive optics.

Speckle interferometry, where no real time phase correction may be applied, continues to develop in the infrared and the visible (Christou), despite the intrinsic limitations of: signal-to-noise degradation, large computing time requirements, and systematic errors. Outstanding results continue to come, such as evidence for structures in circumstellar envelopes or the envelopes of SN1987a.

Optical interferometry is currently limited to the combination of two apertures, very much as the early Cambridge array (Baldwin), but instruments under construction, design



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or consideration extend to as many as 20 telescopes. Fig. 1 illustrates the tendencies: simple, low cost small telescopes, ~10 cm=$r_o$(500nm) in size, built in large numbers; average size telescopes, dedicated to interferometry, in the 1 to 1.5 m class, well suited for a phased aperture in the IR; finally, high sensitivity large new generation telescopes, where adaptive aperture phasing of the aperture becomes possible in the IR, may be interferometrically coupled for part of the time. Radio VLBI shows that high quality (pixel number and dynamic range) images may be obtained with a small number of telescopes. Interesting convergences appear in imaging strategies: the Indian metric telescope combines an array (20 km scale) with a "wide field camera" (1 km scale), fairly comparable to the European VLT with its single dish base (8 m) and its interferometric base (ca. 120 m). New methods such as hypersynthesis (Vivekanand) emerge as specific to optical where *u-v* frequency sampling may be made with short time integrations (seconds).

Coherent detection extends to IR interferometry (Townes), while incoherent imaging detectors rapidly progress in the IR, with formats 64 × 64. First interferometric applications (Mariotti) are promising, although the detectors do not yet reach the signal photon counting mode of visible CCDs. Other convergences reveal themselves: multi-spectral imaging in radio is paralleled with the proposed and demonstrated double Fourier (spatio-spectral) technique in the IR (Ridgway & Mariotti).

Technological progress in optical interferometry is rapid. The MultiMirror Telescope cophasing (Beckers & Hege) has proven the possibility to align large steel structures at the required accuracy, while recent mechanical measurements at ESO and CERGA telescopes (Bourlon) show that classically designed telescopes almost achieve interferometric stability. To paraphrase the "steel-silicon issue" (Ekers) as alternate routes for radio imaging, active and adaptive optics stabilization of large telescope/interferometers is a "glass-silicon issue" of similar nature. The Mt. Wilson small optical interferometer (Shao) indeed demonstrates, by routinely observing in a phase stable mode tens of stars per night, that an optical interferometer may be operated similarly to conventional telescopes.

Many questions remain open. For example, what will be the ultimate sensitivity of an optical interferometer? What dynamic range can be achieved? What is the optimum number of telescopes for imaging? However, the impressive number of projects in this field, the strength and dedication of the community and the way shown by radio interferometry, all combine to predict an interesting future.

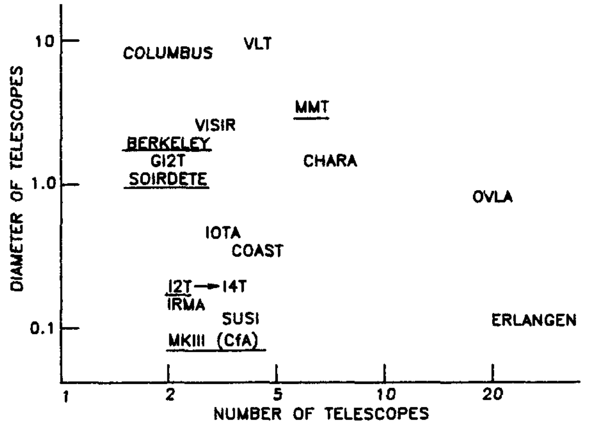


Figure 1. Existing ( ____ ) or planned optical interferometers.

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