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Across the Universe

Exoplanets, Black Holes, and Gravitational Waves

> … we had every advantage we could desire in observing the whole of the Passage of the planet Venus over the Sun's Disk.[1]
>
> Captain James Cook (1769)

The universe holds such marvels that our minds boggle at their magnificence and strangeness. Yet these marvels are so remote that we yearn to bring them closer to explore their mysteries in finer detail. In our quest to bridge astronomically large distances, we turn to the magic of interferometry that divides the tiny length-scale of light—a wavelength λ about a micron in size—by the even smaller angular size α of a distant object to yield an intermediate size $d = \lambda/\alpha$ that we can handle and measure on Earth. Although astronomical distances can be incomprehensibly large and beyond reach, the characteristic length d can be terrestrial in size. Given the range of angular sizes in the sky, the characteristic length d can be the size of the primary mirror of a telescope, or the distance between two or more telescopes separated by baselines of meters or kilometers and even by continental distances. To gain a semiquantitative intuition about this, consider two telescopes on a baseline d = 50 m (about half a football field) observing in the near infrared

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