two landmarks. Each constraint discards information, but can make the remaining ellipse parameters easier to interpret.

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Crucifixion date

SIR—We have suggested[1,2] that the most probable date for the crucifixion was on 3 April in AD 33, in part basing our claim on a lunar eclipse visible from Jerusalem on that evening. However, Clive Ruggles in News and Views[3] discussed a paper by Schaefer[4] claiming that this eclipse would not have been visible from Jerusalem. But there are several errors in Schaefer's work, so we do not think our conclusion needs to be revised.

We found that the eclipse of 3 April in AD 33 was visible from Jerusalem at moonrise: it rose with 20 per cent of its disk in the umbra and the remainder in the penumbra. The ancients, however, made no distinction between the umbral and penumbral shadows with the result that to the casual observer about 57 per cent of the Moon's disk would have been perceived as being 'in eclipse' at moonrise. Schaefer disputes this, mantaining that the rising Moon would first have become visible when only 1 per cent of its disk was still in the umbra and so the eclipse would have gone unnoticed.

The visibility of astronomical phenomena close to the horizon is determined principally by the amount of aerosol scattering in the line of sight. In estimating this, Schaefer takes the altitude of Jerusalem to be 450 m above mean sea level. But the altitude of the old city is typically 775 m. Moreover, his correction factor for the effects of relative humidity is anomalously high. These two errors alone result in the amount of aerosol extinction at the horizon being overestimated by a factor of more than 700.

We would expect the equivalent of any astronomical phenomena seen from present-day Oxford to have been easily seen from ancient, pollution-free Jerusalem: the last three lunar eclipses visible from Oxford were all observed under less than ideal conditions at times when the Moon's altitude was considerably less than the value that Schaefer maintains is required for the Moon to be seen. Moreover, Schaefer's analysis denies the possibility of the simultaneous visibilty of the Sun and eclipsed Moon as a result of atmospheric refraction — a phenomenon that has been known since the time of Hipparchus. Schaefer's analysis, based in part on a single observation of a lunar eclipse setting through the centre of the anthropogenic haze layer of Washington, DC, relies on recent measurements which are degraded by atmospheric pollution. We do not believe that the visibility conditions in ancient Jerusalem and modern-day Washington can be compared.

All calculations of ancient eclipses must take into account the cumulative effects of the inconstant rotation of the Earth due to effects such as tidal friction, for which we have adopted the results of Stephenson and Morrison, who analysed[5] ancient astronomical observations. Schaefer estimates the required eclipse parameters by averaging several disparate eclipse calculations — among which at least one is defective and another is known to be incompatible with the well known eclipses of classical antiquity. After eliminating these two calculations from the set used by Schaefer we find excellent agreement with our own work (which Schaefer has misquoted).

At last umbral contact the Moon is still visibly in eclipse to the casual observer (Schaefer's analysis takes no account of this) and, as a result, the eclipse of 3 April in AD 33 would have been perceived by the general populace as continuing until about 51 min after moonrise. We therefore reaffirm that the partial lunar eclipse on that day would have been easily visible to the casual observer in Jerusalem. We have shown[1,2] that this is the most probable date of the crucifixion and given textual evidence referring to a lunar eclipse following the crucifixion. Schaefer's paper[4] does not provide grounds for doubting this conclusion, which is based on the best available estimate of the clock error due to tidal friction[5] and realistic values for the atmospheric extinction coefficient. We will provide a more detailed response to Shaefer's paper elsewhere.

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Vanishing authors

SIR—Cherry, in his News and Views article[1], gives a good account of the "case of vanishing neutrinos", but by referring only to Bahcall and Bethe for its interpretation, he creates a "case of vanishing authors". The significance of the third, or small-mass-difference, MSW solution was recognized long before the preliminary SAGE results were announced. J. M. Gelb and I were the first to describe its physical properties and to emphasize that it could yield a very small signal in gallium[2]. E. W. Kolb, M. S. Turner and T. P. Walker independently arrived at the same conclusion[3] and our numerical results were cast in analytical form by W. C. Haxton[4] and by S. J. Parke[5]. Other authors refined and extended this work.

In August 1988, the Kamiokande II team announced its first measurement of 0.46 ± 0.15 for the fraction of solar neutrinos detected versus the standard solar model prediction. Gelb and I pointed out[6] that the central value fell within the narrow range of values predicted by the third solution, but well outside the predictions of the high-mass solution. Unfortunately, the error was too large for us to draw a definite conclusion.

We did observe, however, that were the error cut in half and the central value left unchanged, then the high-mass solution could be eliminated and gallium could be used to choose between the other two. With the new results from Kamiokande II and SAGE, this is exactly what has happened.

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■ *Nature* severely restricts the number of citations in News and Views articles, which on this occasion accounts for the absence of reference to these papers in Dr Cherry's article.