Importance of the ACA for Large Scale Structure

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1 The ACA Simulations

While interferometer arrays provide the fine angular detail necessary to understand complex astrophysical structures, the (also important) large scale map features must be added by observations with single antennas and/or arrays of small dishes. The large scale features contain most of the flux and are therefore important for discussions of such quantities as kinetic energy and momentum in gas motions. What is most striking about the excellent simulations of Guilloteau et al, Holdaway, and Morita is that the addition of the ACA generally improves the fidelities in the uv plane for 0-15m, the short spacings. Ekers (1999, AIP Conf.Series 180, vo.180, 321) points out that visibility errors in small regions of the uv plane often have only a small effect on the final maps because a localized error transforms to a low level background error over the whole of the image plane. This is partly just the property of the Fourier transform. It is also the result of the fact that the visibility function of a complex field is mostly small, of the order of 1%, over most of the uv plane, except near the origin where it goes to unity. If the visibility at the origin is missing, the total flux is missing, which is a disaster for a complex extended map. (It is not so important for a collection of point sources.)

2 The Effect on a Model of a Large Scale Feature, a Shell around a YSO

Welch, Hartman, Helfer, and Briceno (2000, ApJ, 540, 362) reported the detection of a large expanding shell around the YSO XZTau. The shell had a diameter of the order of one arc minute and was observed in the emission of $13^{C}O(1-0)$. It required a 7 point mosaic of the 6m BIMA dishes with the addition of total flux from an On-The-Fly map at the NRAO 12m antenna. Theoretical models predict YSO winds extended in angle as well as highly collimated, and such shells may be observed elsewhere. If they turn out to be common, such shells are more likely than the highly collimated winds to be responsible for the clearing of the gas in the molecular cloud as a result of the star formation. The ACA simulations indicate that with pointing errors of the order of 1/10 beamwidth visibility errors may increase from 5% to 10% for 0-15m spacings without the ACA. In order to see what such errors would do to the map of a shell, we study the effect of such short spacing errors on a simple model of a shell. We suppose a 7 pointing mosaic of the ring corresponding to one velocity channel of an expending shell. The radius extends from $6''$ to $8''$ in a simulated map at 0.5mm wavelength. To capture the 10% error, we multiply the circularly symmetric visibility function for spacings less than 15m by a function which scales the visibility to an average of 0.9 (10% error). The factor goes smoothly to unity at the 15m visibility and is 0.8 at the origin. Figure 1 shows both the ideal ring with unity amplitude extending from $6''$ to $8''$ and the distorted version. The peak is reduced by about 5%, and the total flux is reduced by about 20%. The result is only representative, since it is just one form that the error distribution might have. Such errors will make the goal of obtaining fluxes at accuracies of 1-2% difficult to attain.

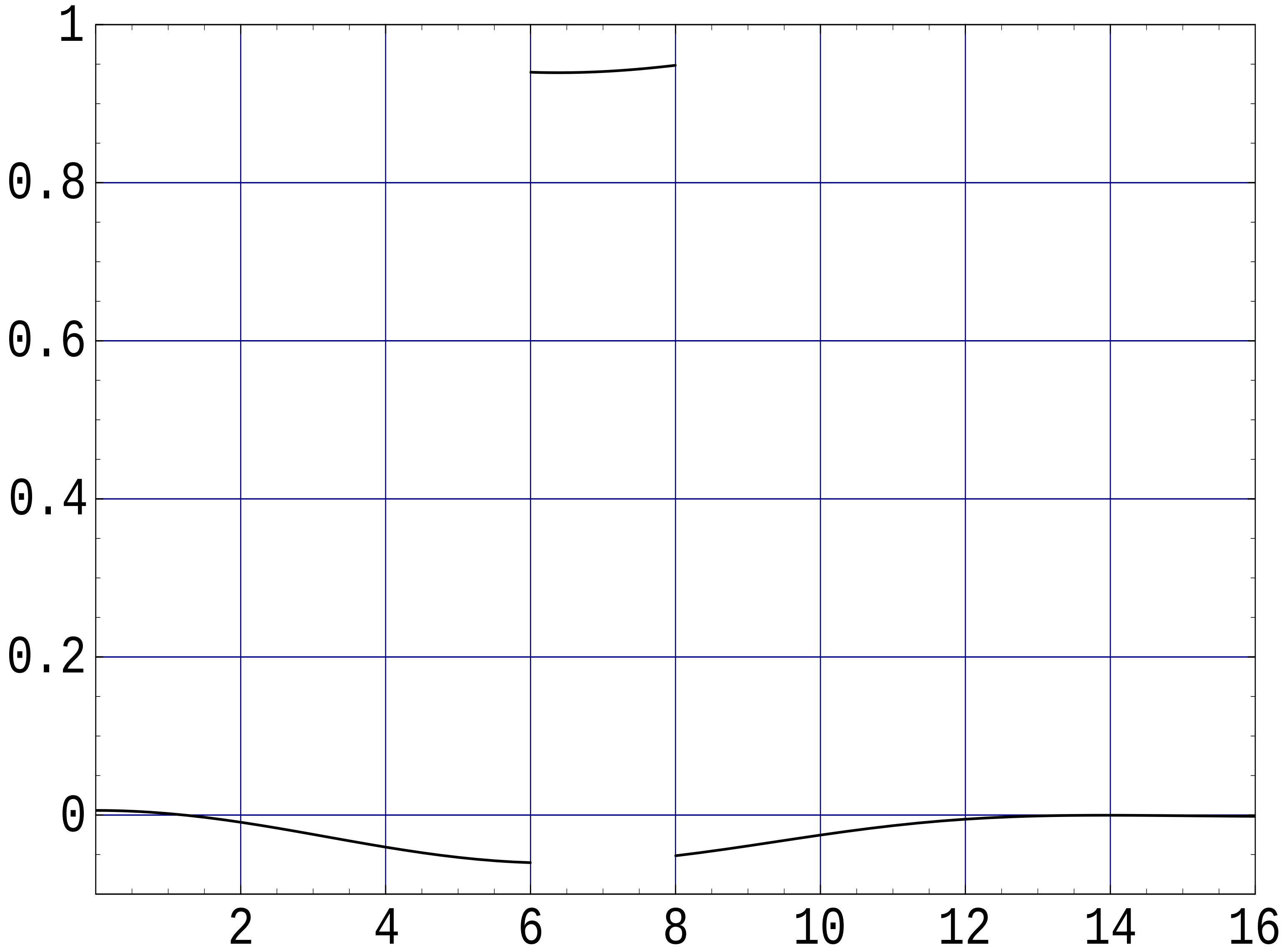

Figure 1: Radial cross-section through a model ring, which is defined by a single velocity channel map of an expanding shell observed in a spectral line. The ordinate is brightness temperature, and the abscissa is radius in arc seconds. The original model has zero brightness from 0 to $6''$, is unity from $6''$ to $8''$, and is zero outside of $8''$. The error in the visibility that produces this distribution is a multiplying function that varies from 0.8 at the center of the uv plane to 1.0 at 15m. This has an average error of 10% over 0 to 15m radius in the visibility plane. The observation is made at 0.5mm wavelength, and the pointing error is about 1/10 of a beamwidth.