

STATISTICAL COMPARISON OF CLEAN AND MEM

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INTRODUCTION

Assume that a set of visibility data

$$\{(u_j, v_j, z_j) \mid j = 1, 2, \dots, N\}$$

is given where visibility z_j observed at time j can be expressed in terms of “true visibility” defined by the brightness distribution $T(x, y)$ and observation noise ε_j :

$$z_j = \tilde{T}(u_j, v_j) + \varepsilon_j \quad (j = 1, 2, \dots, N)$$

$$\tilde{T}(u, v) = \iint \exp\{2\pi i(xu + yv)\} T(x, y) dx dy,$$

where $\{(u_j, v_j)\}$ is a given set of points in the u - v plane. It is assumed that u - v plane is gridded with the interval Δ . The dirty map obtained by

$$M_D(x, y) = \Delta^2 \sum_{j=1}^N \exp\{-2\pi i(xu_j + yv_j)\} z_j$$

is a crude estimate of the true brightness distribution. CLEAN and MEM are two typical methods to get better estimates.

Ishiguro² and Morita (1991) showed that the number of CLEAN components can be determined by the minimum WIC procedure. The purpose of the present paper is to show that WIC can be used to compare the performances of CLEAN and MEM.

SIMULATION STUDY

Dr. T.J. Cornwell's MEM routine “VM” and a CLEAN procedure were applied to data sets generated by assuming the true distribution shown in Figure I.

Values of the minus twice of expected log likelihood (-2 ELL) and WIC for each obtained maps were calculated. Mean values of results of a hundred simulation runs are summarized in Table I.

Inspecting the table two facts are readily seen:

1. Since smaller value of “ -2 ELL ” implies better fit of the map (Akaike 1973), CLEAN procedure is judged to give better results for the present case. CLEAN map with 100 components is the best among the candidates.
2. It is also apparent from the table that “ -2 ELL ” values are successfully estimated by WIC values which are calculated not knowing the true brightness distribution $T(x, y)$.

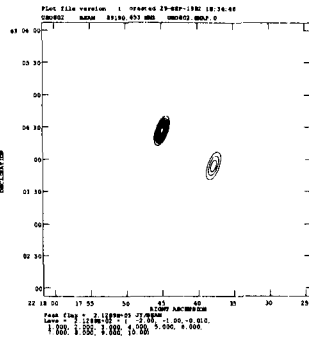


FIGURE I The true distribution $T(x, y)$ with two Gaussian components

TABLE I Information-Criterion

Map	-2 ELL	WIC
MEM Map (small SIGMA)	21466.94	21527.90
MEM Map (medium SIGMA)	20556.41	20632.21
MEM Map (large SIGMA)	21357.34	21390.80
CLEAN Map (N=100) ^a	20305.85	20400.87
CLEAN Map (N=200)	20317.31	20422.90
True Model	20276.32 ^b	20324.91

^a Best map

^b Theoretical lower bound of -2 ELL value

REFERENCES

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(Ishiguro, M.)² and Morita, K.-I. 1991, Application of an Estimator-Free Information Criterion (*WIC*) to Aperture Synthesis Imaging, in *Radio Interferometry: Theory, Techniques and Applications* (Cornwell, T.J. and Perley, R.A. eds.), IAU Coll. 131, ASP Conference Series, 19, 243.