AT/20.1.1/003

OVERALL SYSTEMS & PERFORMANCE
TECHNICAL NOTES AND REPORTS

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THE EFFECT ON THE PERFORMANCE OF THE LBA OF A TELESCOPE AT HOBART

Ray Norris

19 June 1984

1.0 INTRODUCTION

The University of Tasmania are hoping to acquire the Orroral Valley antenna and have it installed near Hobart. If they are successful, then they will probably be interested in allowing it to be used for some fraction of available observing time with the AT LBA. If so, then it will be available at the start of AT operation in 1988. The array will then hopefully consist of the AT antennas (Culgoora, Parkes, and Siding Spring) together with Tidbinbilla and Hobart. This report is an attempt to evaluate the effect of the Hobart telescope on the performance of the LBA.

For this purposes of this report, the LBA is defined as the array of telescopes comprising the Culgoora tied array (53m diam. equiv), Siding Spring (22m), Parkes (64m), Tidbinbilla (64m), and Hobart (25m). This working definition therefore does not distinguish between those telescopes which are part of the AT and those which belong to other institutions.

2.0 UV COVERAGE

Figure 1 shows the uv distributions for the two arrays. The main effect of adding the Hobart antenna is of course to increase the maximum baseline. However, Figure 1 shows that it does so in a particularly useful way, in that the gaps in the uv plane are not significantly increased. In other words, the spacing in a North-South direction of the five telescopes is close to optimum for maximum uv coverage. The uv coverage for the five-telescope array is therefore substantially better than for the four-telescope array.

The resulting uv distribution does, hoever, still suffer from a lack of East-West coverage. In the long term this could be rectified by the addition of other telescopes. In the short term, it will result in a reduction of map quality. However, it will be shown below that this is not a problem for the compact sources which are best suited to this array.

3.0 RESOLUTION

The addition of the Hobart antenna increases the maximum baseline to 1420km, increasing the LBA resolution to 0.026 arcsec at 1.67GHz and 0.005 arcsec at 8.4GHz. This increase in resolution causes a corresponding increase in the amount of new science that can be expected from the LBA, since it is at milliarcsecond resolution that many astrophysical processes of keen current interest occur (e.g. jets in quasars).

4.0 SELF-CALIBRATION

The addition of a fifth telescope to a four-telescope array increases the number of baselines by a factor of 1.67, and thus increases the number of constraints on a self-calibrated solution by a similar factor. Thus a more reliable solution is obtained, leading to higher quality maps in the presence of phase and amplitude errors.

5.0 SIMULATIONS

Figures 2 to 4 show simulations of sources observed with the 4-telescope and 5-telescope arrays. In many cases, the increase in map quality resulting from the addition of Hobart is not simply due to the increase in resolution, but is also due to the better uv coverage.

The best example of this is the test source VIRGO. Figure 2 emphasises the effect of increased resolution on this compact source, but comparison of the declination -60° map with Figure 5 shows that at least some of the improvement is due to the better uv coverage. The North-South sidelobes have disappeared from the 5-telescope map, and the brightness distribution of the jet resembles the model more closely.

The effect of the resolution increase is also apparent in Figure 3. The map is reliable at all declinations up to $+10^\circ$, although at low absolute declinations North-South artefacts start to appear. The five compact sources along the central East-West line also seem to be split into nine sources at declination -10°. Nevertheless, it is clear that a great deal more science could be obtained from the maps in the bottom row of Figure 3 than from those in the top row.

The complicated source SPIRAL was also mapped, and the results are shown in Figure 4. Because of the complexity of the source, these maps are less successful than the others. However, it is again clear that the maps are reliable down to the levels of the first negative contour, and the spiral structure is clearly evident in the 5-telescope maps at declinations -60° and -30°. Again, a scaled version of this source is shown in Figure 5, demonstrating that some of the improvemnt is due to the greater uv coverage.

6.0 CONCLUSION

The simulations have shown that the addition of the Hobart antenna to the LBA :

a) Increases the resolution by a factor of about 2.5 which in itself represents a major enhancement of the astronomical potential of the LBA.

b) Increases the uv coverage of the array, leading to higher quality maps.

c) Increases the number of 'closure triangles' in the array, thereby increasing the effectiveness of self-calibration schemes, resulting in higher quality maps.

Top Row: Culgoora - Siding Spring - Parkes - Tidbinbilla

Bottom Row: Culgoora - Siding Spring - Parkes - Tidbinbilla - Hobart

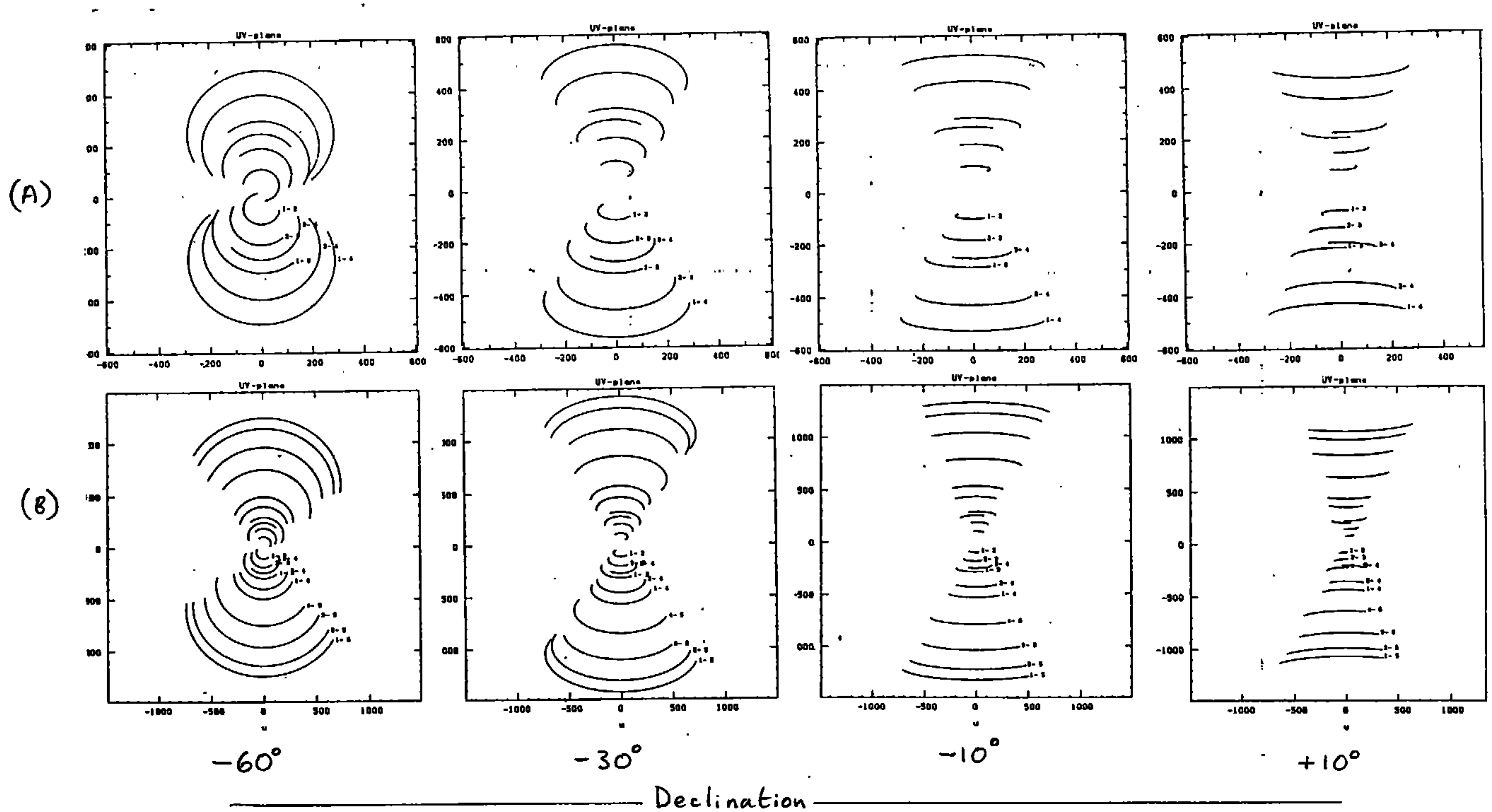


Figure 1. UV diagrams for the two arrays. Note that the bottom row is scaled up from the top row by a factor of about 2.5, so that each of the top diagrams is reproduced in the inner central part of the corresponding bottom diagram.

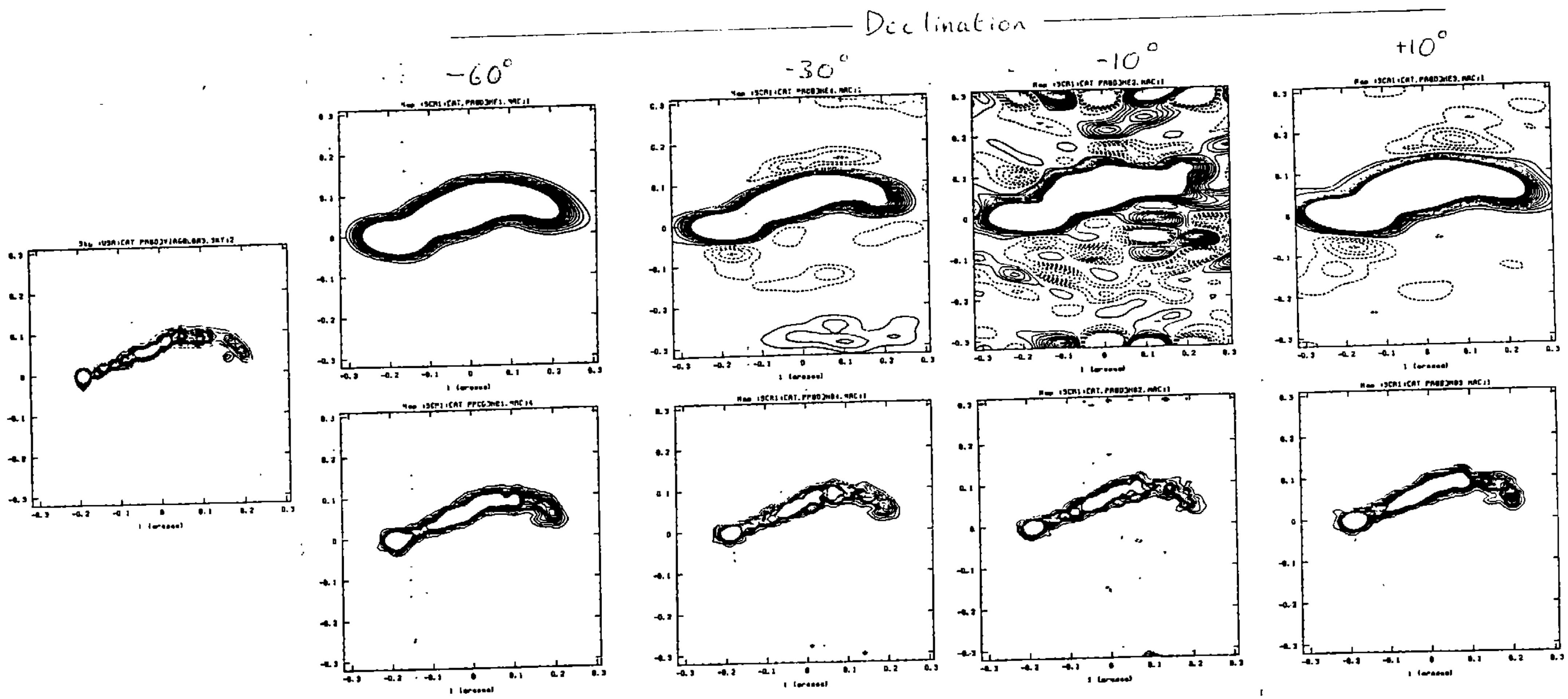
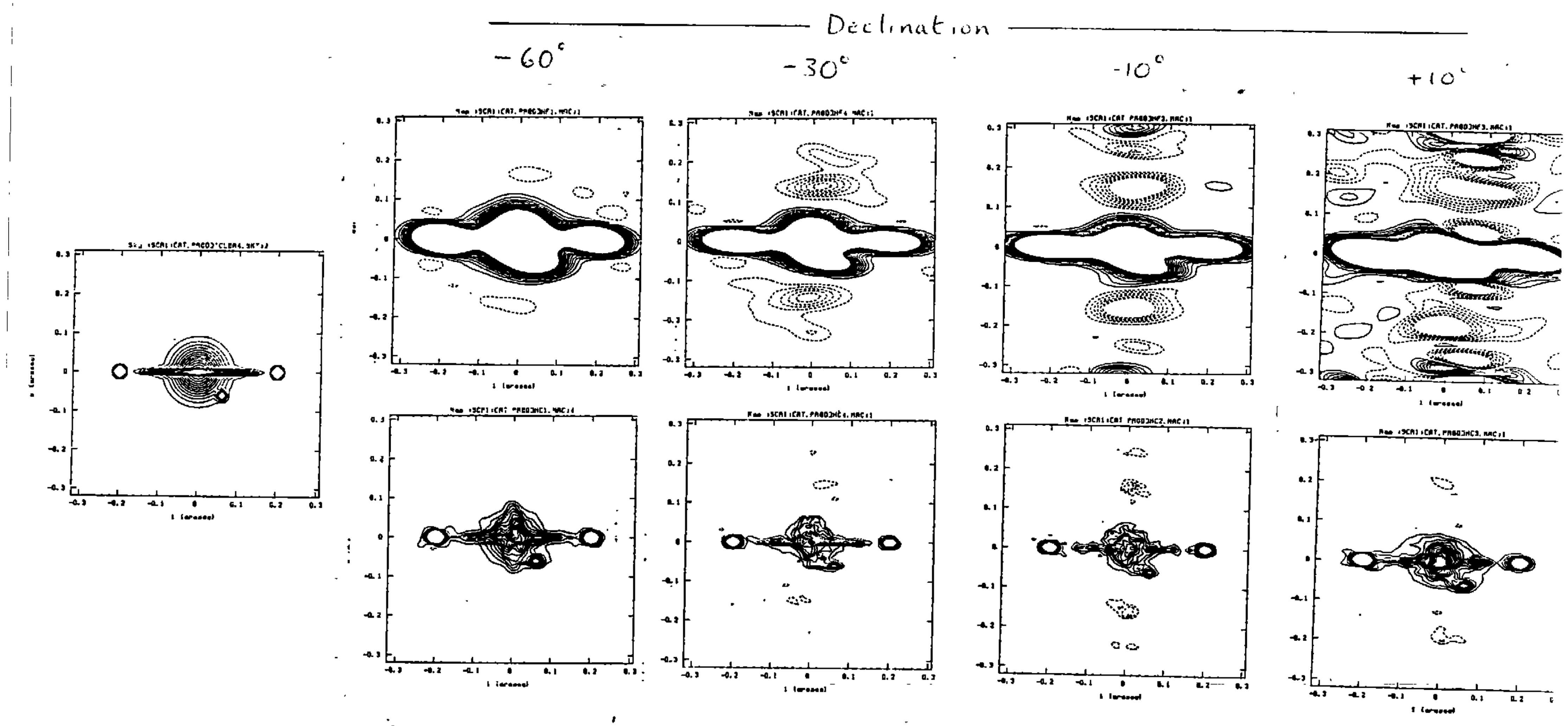


Figure 2. Simulated observations of the test source VIRGO (suitably scaled). The top row shows maps made with the Cul-SS-Pks-Tid array and the bottom row shows maps made with the Cul-SS-Pks-Tid-Hobart array. The extreme LH map shows the model sky used for the simulations. In each case not only has the resolution improved, but the map quality has also improved because of the greater uv coverage. Contours are drawn at 1% intervals.



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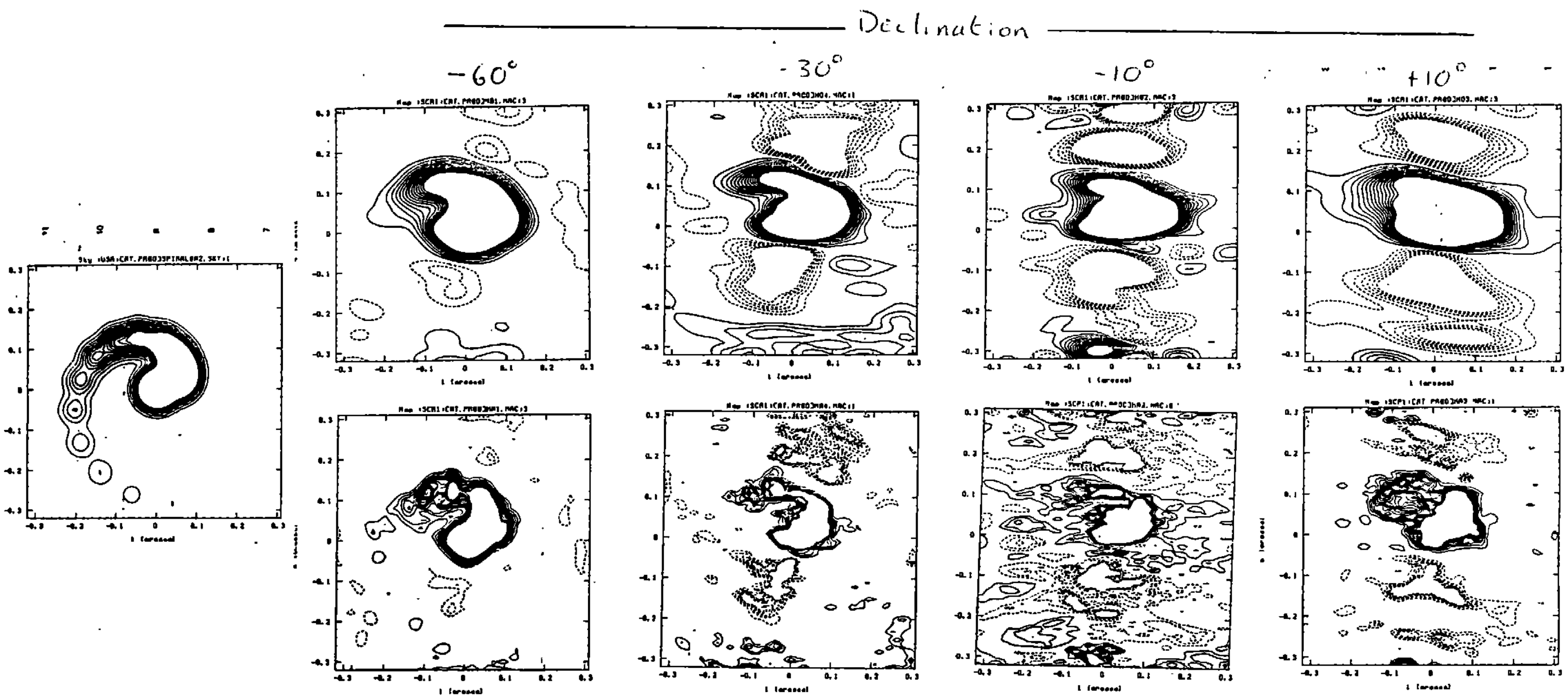

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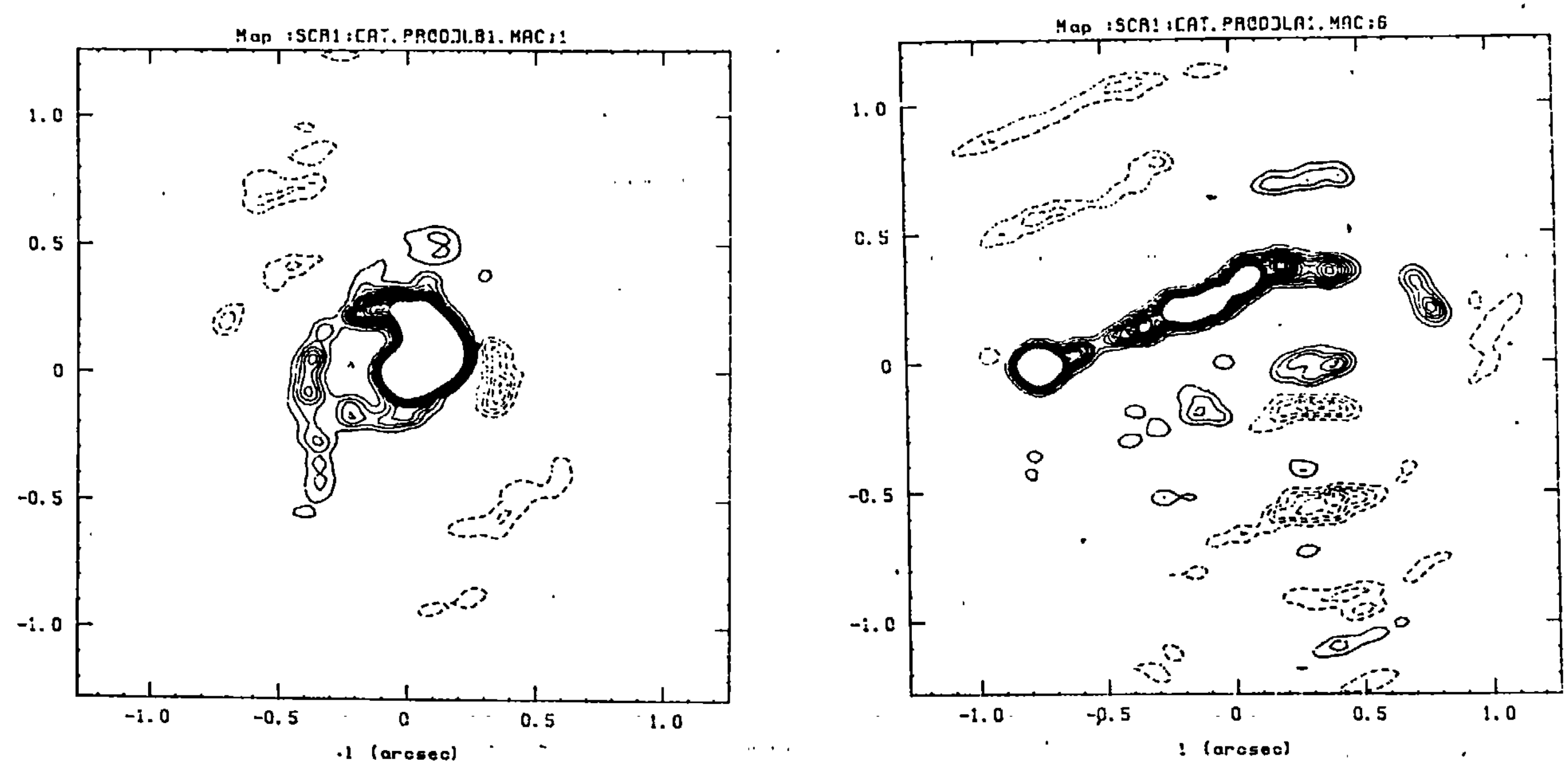

Figure 5. Simulated maps of the sources SPIRAL and VIRGO, made with the Cul-SS-Pks-Tid array at Declination -60° . The test sources have been scaled so that they are approximately the same size relative to the beam of the Cul-SS-Pks-Tid array as Figures 2 to 4 are to the beam of the Cul-SS-Pks-Tid-Hobart array. Thus the increase in map quality apparent in Figures 2 to 4 is partly due to the greater UV coverage rather than simply being a result of higher resolution.

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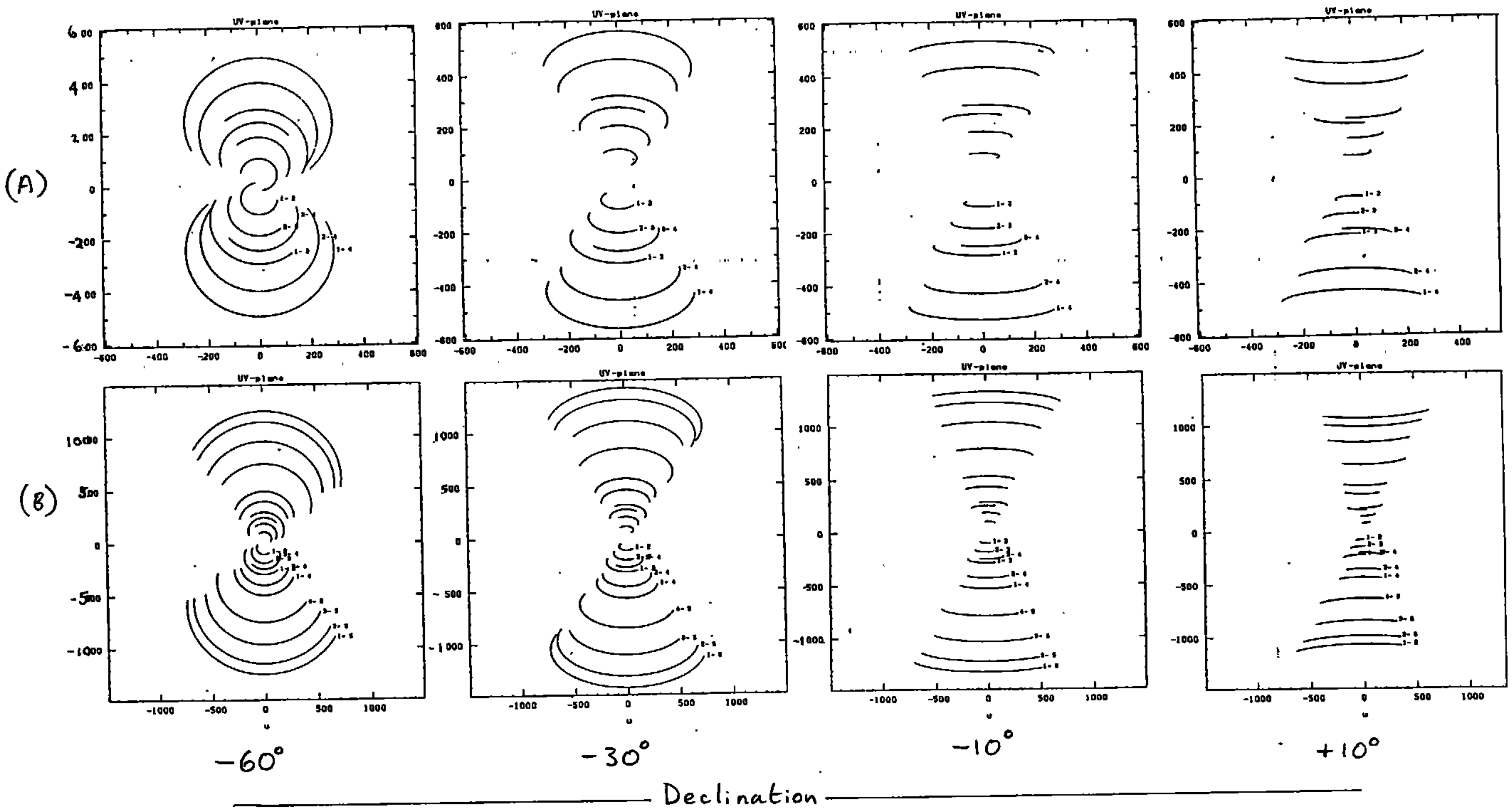

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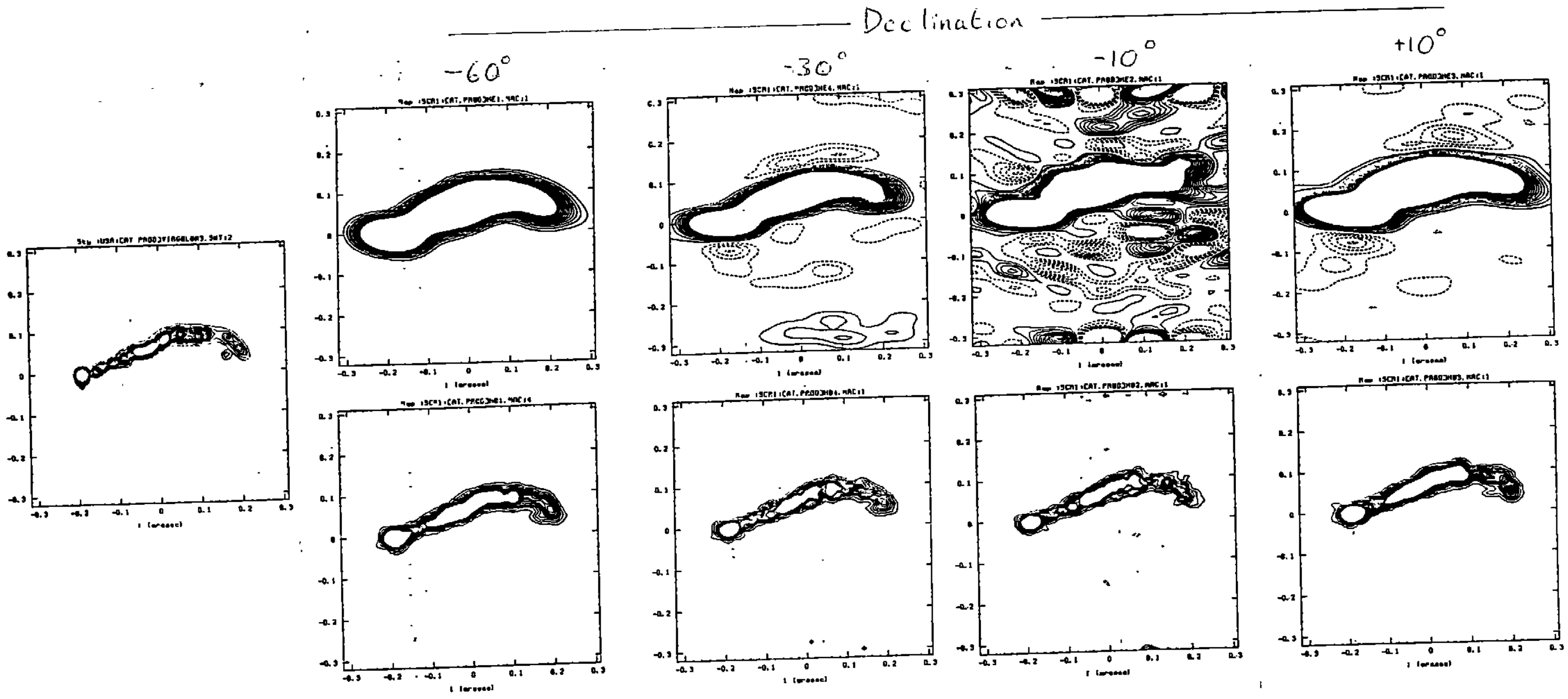

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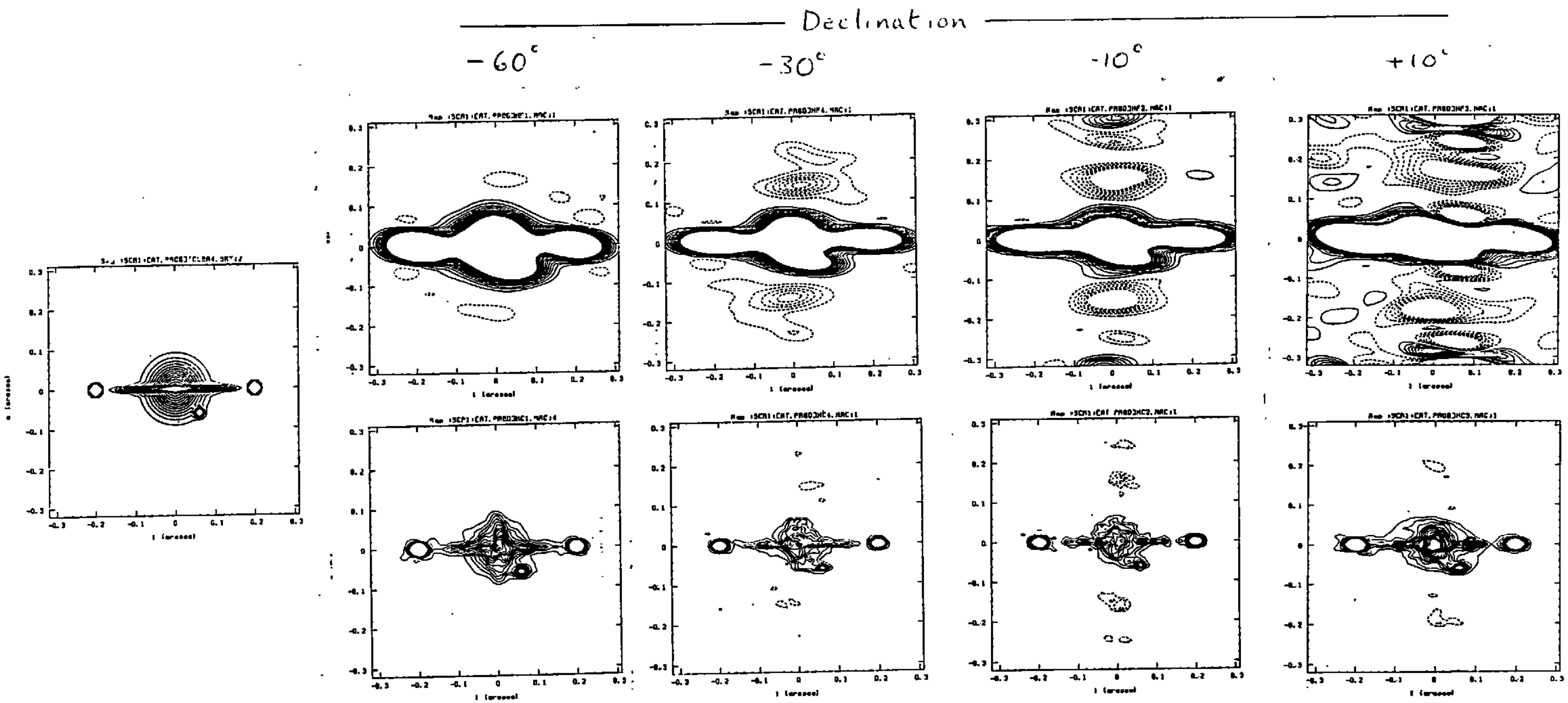

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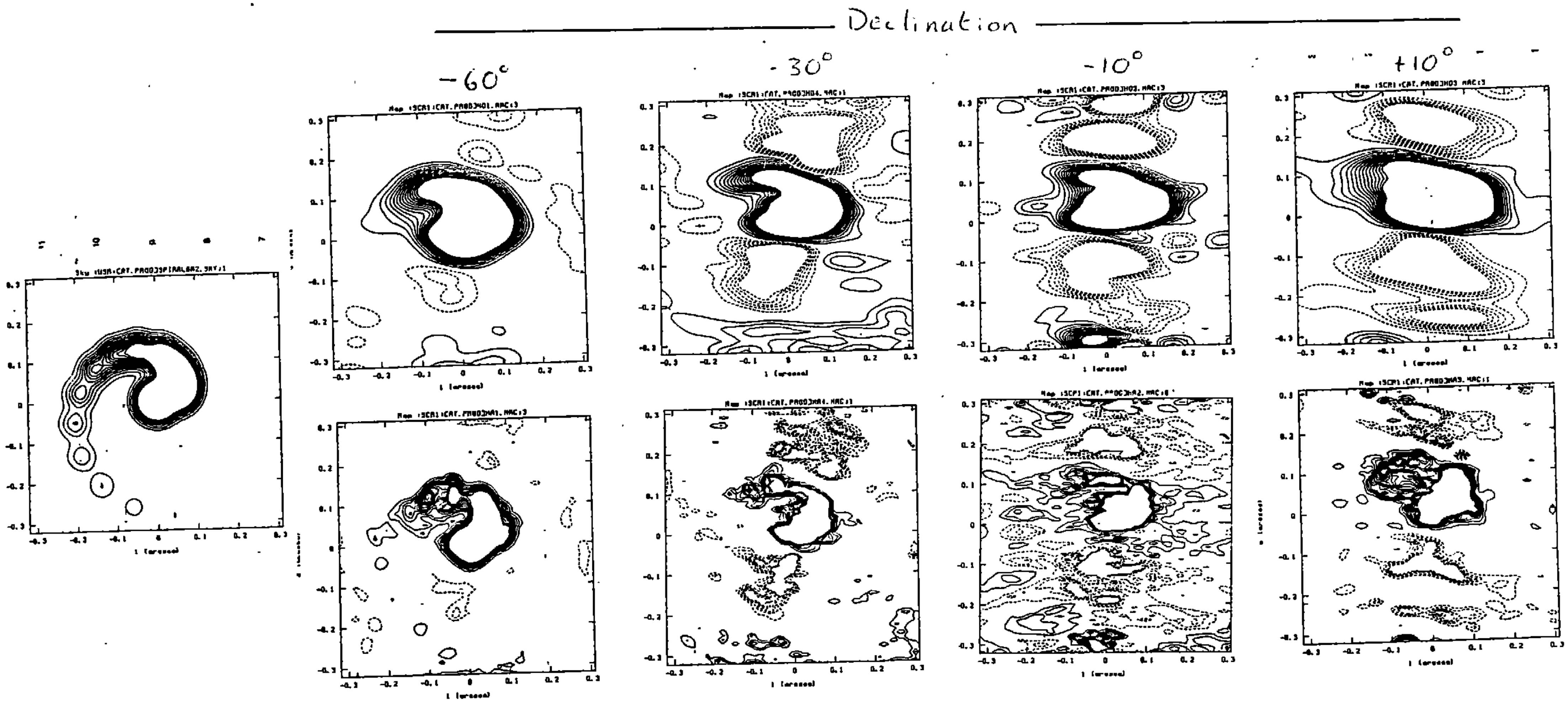

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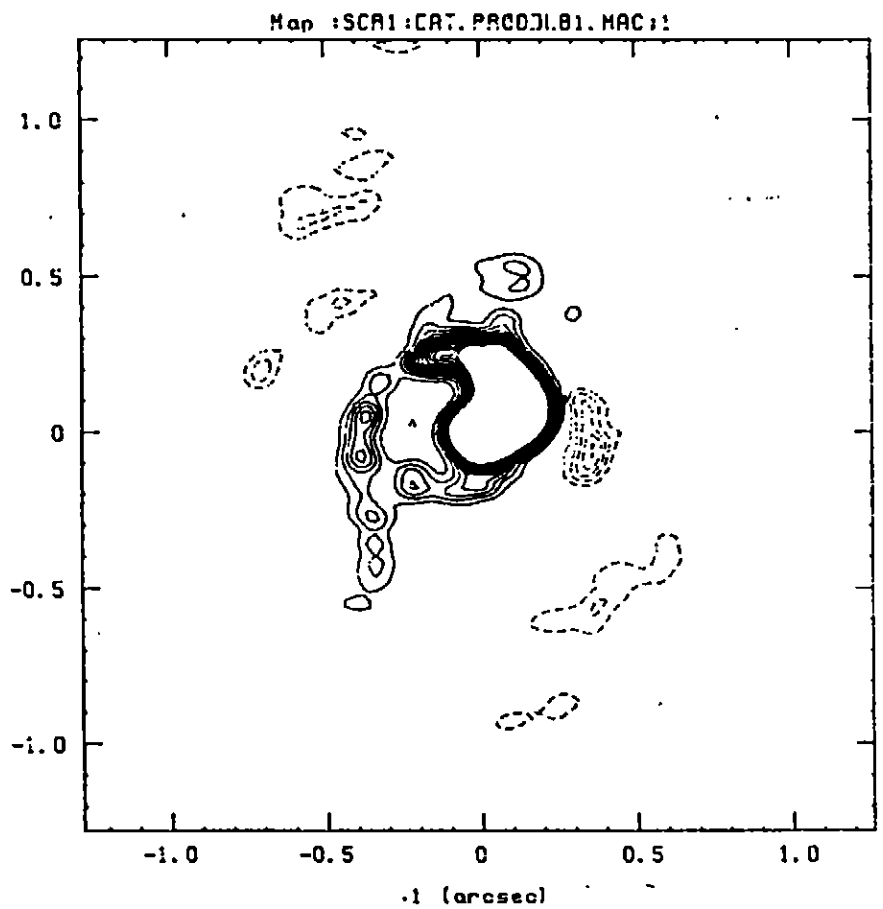

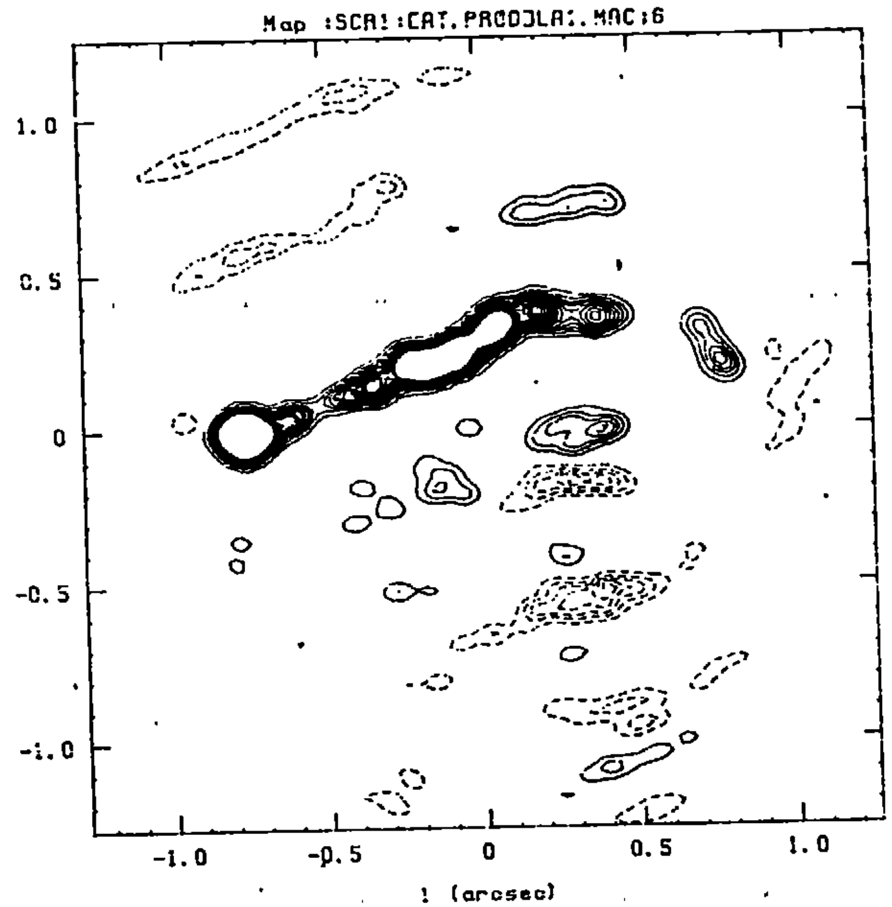

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