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ASPHERIC OPTICAL SYSTEMS

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Abstract

During this period we have concentrated on the design problem in aspheric optical systems. Most of our effort has gone into learning how to use large computers at a remote location. Our studies so far have convinced us that large computers are needed to cope with the problem of optimum design with the full exploitation of aspheric surfaces. We have procedures fairly well worked out for using an I.B.M. 7044 at [redacted] STAT and an I.B.M. 7094 at the White Sands Missile Range. We are now returning to detailed lens studies of lenses with aspheric surfaces.

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Detail of Research during this period.

A. The Aspheric Triplet Design

An aspheric triplet design was described in the previous report. A brief review of this problem is the following:

1) An all spherical triplet and an aspheric triplet were designed on ORDEALS. The specifications were published in the proceedings of the ICO Conference in Tokyo. This study showed insignificant gain in using four aspherics. We were not confident, however, that we had designed a true optimum aspheric design. The aspheric design was done on the ORDEALS program which is a semi-automatic program. We believe that the aspheric design problem over extended this program.

2) We redesigned the aspheric lens on the [ ] program STAT using the I.B.M. 7094 at White Sands. The first few attempts appeared to be encouraging. This new aspheric design was described in our previous progress report and in a paper presented to a meeting of S.P.I.E. at El Paso, Texas. The STAT [ ] program designed the aspheric coefficients completely different from what we had done on the ORDEALS program. STAT [ ] program succeeded in balancing out large high order aberrations. We designed our triplet on the philosophy of trying to find solutions with small high order aberrations.

STAT The result is that the [ ] program provided remarkably flat aberration curves, but they are badly rippled. We have since then computed the Strehl definition for the [ ] design and STAT this shows that the rippling has disastrous effects. The Strehl definition in the axial image was only 0.31.

Summary of Triplet Study

The triplet study has, we believe, shown that optimizing aspheric lenses is far more difficult than we anticipated. The large automatic design program of [ ] turns out designs STAT quite different from the one designed on ORDEALS. At the moment it is difficult to say that it turns out better lenses but it appears to offer much more potential. We can not prove definitely our point but we believe the triplet study is showing that for this problem the use of four aspheric surfaces is not worthwhile. The slight improvement we gain is not worth the extra cost of the aspherics. Before dismissing the problem we should introduce one aspheric into the triplet. If we could achieve the improvement so far shown with one aspheric then it might be a practical advantage. We plan to do this to complete the triplet study.

B. The Heliar Study

In the I.C.O. paper we also presented an optimized Heliar lens which was designed on ORDEALS. Since that time

we have made several new designs on ORDEALS, FLAIR and the

STAT [ ] program. These designs were described at the S.P.I.E. meeting in El Paso. We now believe we have a truly optimized Heliar design. We plan to use FLAIR to design a Heliar with aspherics. This time we are going to first introduce a single aspheric.

C. The F/3.5 Triplet.

The triplet described in our previous report was an F/6, 24 inch focal length lens to cover a 9" x 9" format. In the I.C.O. paper we warned that one can not conclude that aspherics are of little help in all lens problems. For example, we believe that aspherics will more clearly improve a faster narrow field triplet. We have therefore started the design of an all spherical f/3.5 triplet with a 24" focal length covering a 5" x 5" format.

D. The Lens Design Programs.

In order to use large machines we have had to make a major programming effort. We have taken two routes.

1) We have attempted to use the [ ] program on the STAT White Sands 7094, through the use of mail service. This has been extremely slow and frustrating. A card-to-card data link has been ordered, and should be installed by May 1, 1966.

2) Many changes have been introduced into FLAIR. This is a program which can be run on a 7044 or a 7094. We are testing it out on a machine at the [redacted] We have had to add many decision making features in order to make up for the fact that we can get only one run a day.

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