3.6-m Telescope Cassegrain Adapter on La Silla

While this issue of THE MESSENGER goes to press, the Cassegrain adapter is being installed on the ESO 3.6-m telescope. Soon after, the optical tests for the Cassegrain focus will commence, and if all goes well, the first astronomical observations may be made some weeks later.

What will it be like to observe in the Cassegrain cage? We have already assured the future visitors that they will be firmly attached (see THE MESSENGER No. 6, p. 15). This article adds to the picture by describing in some detail the so-called "Cassegrain Adapter", on which all auxiliary instruments to be used in this focus will be mounted. The reader will undoubtedly notice that the text is somewhat more technical than usual in this journal. However, we have felt that it is of importance to those astronomers who are already now planning to use the ESO main telescope to be informed about this adapter as early as possible.

The authors, ESO engineers Sten Milner and Manfred Ziebell, work in Geneva. They have followed the adapter from the earliest design stage to the final tests.

While the year 1976 was characterized by the final construction, erection and first operation of the 3.6-m telescope, it was also the year of manufacture, assembly, mechanical, electronic and optical tests of the Cassegrain instrument adapter for the same telescope.

The provisional tests made at ESO, Geneva, showed satisfactory performance and the adapter was shipped to La Silla on January 20, 1977. The mounting of the adapter onto the telescope started on February 22, 1977.

The adapter shown in Fig. 1 is the mechanical interface between the telescope and the different instruments to be used in the Cassegrain focus. It contains the optical parts and the mechanical facilities required for direct and remote observing of the quality and focussing of the centrefield, and for the spectrometer slit and the guiding of the telescope. The adapter will be mounted directly onto the rear side of the main mirror cell inside the Cassegrain cage, and the control electronics will be installed in one of the four cubicles inside the cage. The adapter will be controlled either by a control panel inside the cage or remotely by the 3.6-m telescope control computer.

The optical path and component location are shown in Fig. 2.

For remote observing, one television camera is installed for centrefield viewing and a second one for guide star observation. The centrefield camera uses an EBS (Electronic Bombarded Silicon Target) tube with an image intensifier in front of the tube. The input window has a diameter of 40 mm. For large-field viewing, the image of a star with a "seeing" of 1" will cover 2 lines and for small-field viewing 16 lines. The estimated limit of sensitivity for large viewing will be in the order of the 17th magnitude on the 3.6-m telescope. To raise the sensitivity of the centrefield, this camera will be replaced by another one with facilities for integration both on the target and in a digital memory.

For guide-star observation, a less expensive television camera with an ISIT -(Intensified Silicon Intensifier Target) tube is used. The estimated sensitivity will be of the order of the 16th magnitude with a resolution of 4.5 lines per arc sec. To begin with, guiding will be carried out manually using the handset. Later on, this TV system will be replaced by an automatic guider.

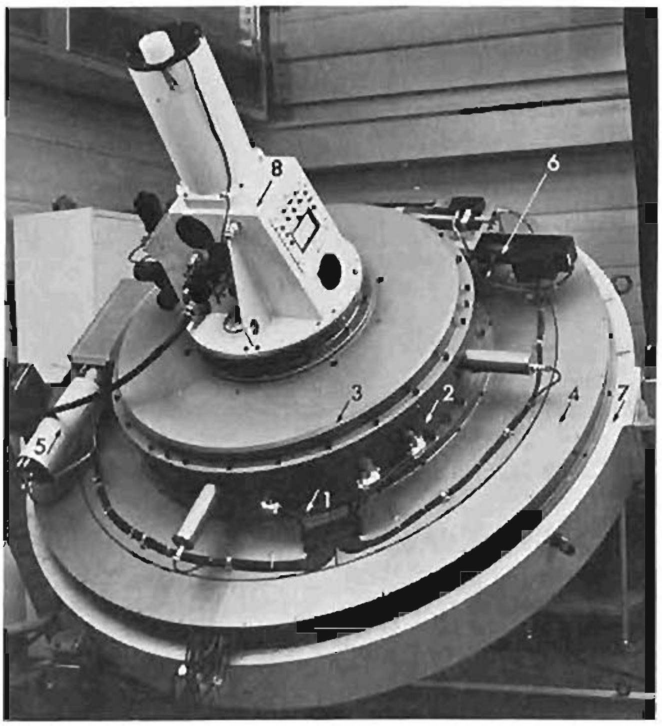

Fig. 1: *CASSEGRAIN INSTRUMENT ADAPTER ON TEST BENCH. — (1) rotator, (2) adapter housing, (3) reduction plate, (4) cable guide, (5) TV camera for centrefield observation, (6) ISIT camera for guiding, (7) test bench, (8) spectrograph.*

Adapter Design

The adapter is divided into 4 mechanical sub-groups. They are: Rotator, Housing, Reduction plate and the Cable guide.

The *rotator* is a large precision roller bearing on which the adapter housing is bolted. The bearing is provided with internal gear teeth and is directly bolted onto the reference plate on the rear side of the mirror cell. It is turned by 3 parallel driven AC motors up to ± 182° from the South direction. The rotation is limited by electrical and mechanical stops. To eliminate the backlash in the gear and any uncontrolled motion during the telescope movement, a special sequence of motor control is used. The angular position is read by an absolute encoder with a resolution of 0°.037.

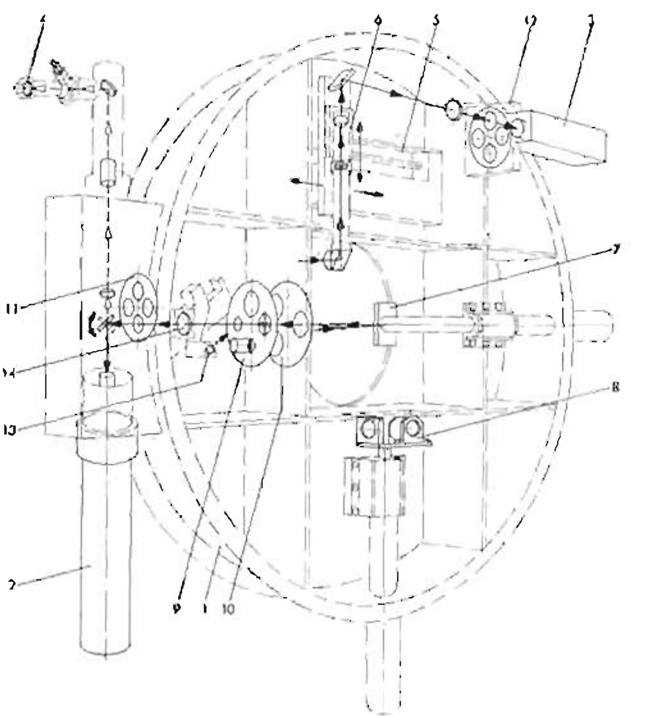

Fig. 2: *SCHEMATIC OF OPTICAL PATHS AND COMPONENT LOCATION. - (1) adapter housing, (2) TV camera for centrefield observation, (3) ISIT camera for guiding, (4) eye-pieces, (5) X-Y displacement table, (6) guide probe with focus-reducer -- 90 prism – cross-hair – collimator lens – plane 45°-inclined mirror, (7) centrefield mirror, (8) slit viewing unit, (9) turret for field lenses · cross-hair and knife edge, (10) turret for glass thickness compensation, (11) filter turret for TV camera, (12) filter turret for ISIT camera, (13) small-field objective, (14) large-field objective, (15) plane mirror on pivot for eye-piece or TV observation.*

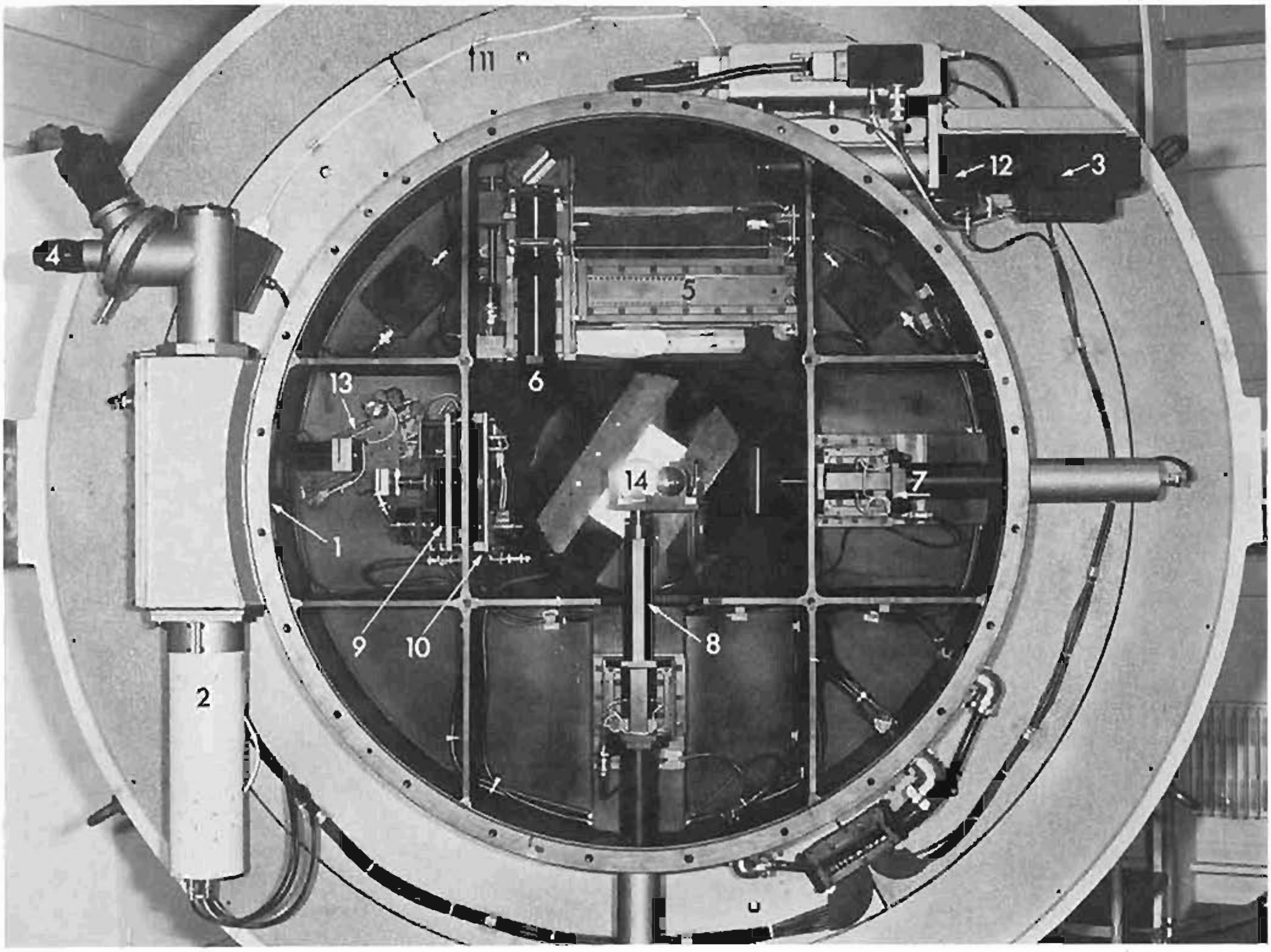

Fig. 3: *ADAPTER HOUSING WITH REMOVED REDUCTION PLATE. – (1) adapter housing, (2) TV camera for centrefield observation, (3) ISIT camera for guiding, (4) eye-pieces, (5) X-Y displacement table with guide probe, (6) guide probe, (7) centrefield mirror actuator, (8) slit viewing unit actuator, (9) turret for field lenses – cross-hair and knife edge, (10) turret for glass thickness compensation, (11) cable guide, (12) filter turret for ISIT camera, (13) carriage for small and large-field objectives, (14) star-simulation device for calibration of the adapter.*

The accuracy of the positioning will be 1/10 of a degree. The bottom face of the bearing is the connection flange for the adapter housing.

The *housing* contains the optical components and related actuating mechanisms as shown in Fig. 3. It is a welded cylindrical steel structure with a plain base plate and 4 strengthening ribs assuring sufficient stiffness to the structure, resulting in less than 5 μm distortion of any reference surfaces of the optical component actuating mechanism, when the housing is tilted from 0 to 45°.

The lower flange end is connected either to a large instrument, such as an echelle spectrograph, or to the *reduction plate* carrying the smaller instruments such as a spectrograph, photometer or camera. The X-Y displacement table positions the guide probe within the area of (308 x 149) mm² of the image field, 305 mm from the focal plane. As the adapter can be turned ± 182°, the complete field can be scanned by the guide probe. The X-Y displacement tables are guided in preloaded linear bearings and driven via "play-free" satellite roller screws by means of tachometer DC gear motors. The positions of the tables are given by rotating incremental optical encoders located on the end of the roller screws. The zero position (initialization) is given by a microswitch at the end of the stroke and the first zero pulse of the encoder. The reproducibility of the zero position is 4.2 μm. Within the scanning area the resolution for the guide-probe position is 1.4 μm, the reproducibility will be 5.6 μm and the total accuracy is better than ± 20 μm, deflection included. The time to move the guide probe across the field is 30 sec in X (308 mm) and 15 sec in the Y direction (149 mm). The cables for motors, switches and cross-hair illumination are collected in a cable guide on the side of the X displacement bed. When the adapter is controlled in a manual mode, from the control panel inside the Cassegrain cage, only the speed control feedback loop via the tachogenerator is closed and 2 speeds, fast and slow, are foreseen. The position feedback loop is closed via computer control. When the guide probe reaches its commanded position, the speed is regulated down by computer via a 12 bit D/A converter.

Two identical actuators support and position the centrefield mirror and slit viewing units in the field with a reproducibility of ± 10 μm. The time for displacement (205 mm) from "out" to "in" position is 15 sec. The actuator consists of a ram guided by two recirculating linear bearings engaged in two opposing 90° grooves in the ram. The ram is moved by a screw nut system driven by a DC motor. The "in" and "out" positions of the ram are defined by two mechanical stop plates at the end of the stroke and these positions are indicated by microswitches. The drive motor is controlled by a power amplifier which has, in addition to the negative voltage feedback, a positive current feedback loop to give a negative impedance output characteristic. This is a substitute for tachometer feedback because of less severe requirements for speed stabilization. It functions in the following way: when the friction torque rises, the motor speed will try to go down. The loss of "back-EMF"

New CERN/ESO Telephone Number

As from March 18, 1977 CERN's general telephone number will change from 41 98 11 to 83 61 11.

It will then also be possible for people telephoning from outside CERN to dial the ESO extensions directly, by composing 83 followed by the present internal number. For example:

Scientific Group: (022) 83 50 80
Engineering Group: (022) 83 46 92
Instrumentation Development Group: (022): 83 48 31
Sky Atlas Laboratory: (022) 83 48 34
Geneva Administrative Group: (022) 83 48 38

will increase the motor current and, because of the positive current feedback, the amplifier will raise the output voltage to stabilize the motor speed. At the "in" position of both actuators, the limit switches are bypassed by a resistor. This drives the ram with reduced torque against the mechanical end stops to increase the reproducibility (± 10 μm). An interlock system insures that only one of the units (slit viewing, centrefield mirror or guide probe) can be moved into the centre of the field at a time.

The turret for the cross-hair, knife edge and the large and small field lenses, positions the first two elements with a reproducibility of ± 10 μm in the focal plane. The position of the wheel is assured by a spring-loaded precision lever, engaging a "play-free" ball-bearing in 4 slots on the periphery of the turret. The time to change from one element to the next is 3 sec. Two microswitches serve for position indication. One switch indicates the zero position and the other one counts the steps from zero to the selected element. As the reduction between the DC motor and the turret wheel is very low, it was necessary to install a circuit with a negative impedance characteristic to achieve sufficient speed control at slow speeds. To change to a new position, the motor is driven for 20 ms with full torque to throw the wheel out of the blocked position (ball-bearing in slot). Then the turret continues turning at slow speed until the next position indicated by the position switch. The same electrical system is used by the turret for thickness compensation, and the two filter turrets for centrefield viewing and the ISIT camera.

The turrets for glass thickness compensation and the two TV filter turrets are built and controlled like the field-lens turret, but less precisely.

The carriage for large and small field-viewing objectives is guided in linear bearings and moved into position by means of a DC gear motor. It is held in the end position by two magnets with a precision of ± 100 μm. The time for full stroke is 15 sec.

The reduction plate is a solid, stabilized steel plate, precision-machined to a planarity of 10 μm of the flanges. The bolt circle diameter of the large flange is 1135 mm, and the internal guide bore 1100 mm. The bolt circle diameter on the small flange is 540 mm and the guiding bore 500 mm. The focal plane is 170 mm from the small flange. The weight of this plate is 500 kg to prevent a serious imbalance in the telescope during a change from a heavy to a light instrument.

ALGUNOS RESUMENES

Fuentes de rayos X en cúmulos de galaxias

Dr. R. Havlen, astrónomo de ESO en Chile, y Dr. H. Quintana, astrónomo chileno empleado por ESO en Ginebra durante 1976, han realizado recientemente un minucioso estudio del cúmulo austral de rayos X de galaxias CA 0340 -538.

Cúmulos de fuentes de rayos X tienen una apreciable dimensión, siendo su diámetro de uno o dos millones de años luz. Se presume que la radiación de rayos X en estas fuentes no es más que la radiación termal de un tenue, muy caliente gas (con una temperatura de cien millones de grados) que llena las regiones interiores de los cúmulos. Hasta el momento aun no se puede responder a la pregunta de cual sería el origen de aquel gas.

Hasta la fecha, se han podido detectar sólo una o dos docenas de cúmulos de fuentes de rayos X. Es importante identificar estas fuentes a fin de estudiar en detalle los cúmulos ópticos.

El cúmulo CA 0340 -538 es un cúmulo casi esférico que tiene muchos cientos de galaxias. Para varias galaxias se han determinado las velocidades radiales, y se encuentra en progreso un estudio fotométrico. De las placas tomadas con el telescopio Schmidt en La Silla se está realizando también un estudio de la morfología y distribución de los varios tipos de galaxias en todo el cúmulo. Toda esta información, si se combina con los datos de rayos X, ayudará a explicar el origen del gas intercúmulo y su mecanismo de calentamiento.

Apolos y Troyanos

El título de esta nota no debe confundir a los lectores. No pretendemos discutir antiguos dioses y guerreros griegos, sino más bien resumir algunas nuevas informaciones pertenecientes a estas dos «familias» de planetas menores recientemente obtenidas a través de observaciones con los telescopios de la ESO. Ellos representan casos extremos en el mundo de los asteroides: los planetas de tipo Apolo son aquellos que más se acercan a la tierra, los Troyanos son los más distantes de todos los conocidos planetas menores.

1976 WA

Hasta la fecha se conocen comparativamente pocos asteroides de tipo Apolo. Recientemente, el interés en estos raros objetos ha aumentado considerablemente luego del descubrimiento de no menos de cuatro nuevos Apolos dentro de sólo once meses. A fines de 1975 fueron descubiertos dos en el Observatorio Palomar (1976 AA y 1976 YA), el tercero en octubre de 1976, igualmente en Palomar (1976 UA), y el cuarto, 1976 WA, fue el primero encontrado con el telescopio Schmidt de ESO, para el cual se ha establecido igualmente una órbita fiable.

1976 WA fue descubierto por H.-E. Schuster en una placa tomada para el Mapa (B) de ESO el día 19 de noviembre de 1976. El tamaño de 1976 WA se estima en 1–1,5 kilómetros. Su órbita es extremadamente alargada y se mueve entre 124 y 598 millones de kilómetros del sol, es decir, pasando bastante detrás de la órbita de Marte y casi tocando la de Venus.

1976 UQ y 1976 UW

Algunas semanas antes del descubrimiento de 1976 WA, se realizó un pequeño programa de observación con el telescopio de Schmidt de ESO con el fin de buscar sistemáticamente nuevos asteroides de tipo Apolo. Dr. R. M. West, asistido por Guido Pizarro, obtuvo seis placas durante un período de diez noches. Se encontraron 27 planetas menores en las placas, 25 de los cuales eran nuevos descubrimientos!

Entre los 25 objetos no habían nuevos asteroides de tipo Apolo. Sin embargo, sorpresivamente, dos de los nuevos asteroides resultaron ser nuevos Troyanos con una distancia de casi 750 millones de kilómetros de la tierra. Una extraña paradoja: se busca lo cercano y se encuentra lo distante.

ESO, the European Southern Observatory, was created in 1962 to... establish and operate an astronomical observatory in the southern hemisphere, equipped with powerful instruments, with the aim of furthering and organizing collaboration in astronomy... It is supported by six countries: Belgium, Denmark, France, the Federal Republic of Germany, the Netherlands and Sweden. It now operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where nine telescopes with apertures up to 3.6 m are presently in operation. The astronomical observations on La Silla are carried out by visiting astronomers—mainly from the member countries—and, to some extent, by ESO staff astronomers, often in collaboration with the former.

The ESO Headquarters in Europe will be located in Garching, near Munich, where in 1979 all European activities will be centralized. The Office of the Director-General (mainly the ESO Administration) is already in Garching, whereas the Scientific-Technical Group is still in Geneva, at CERN (European Organization for Nuclear Research), which since 1970 has been the host Organization of ESO's 3.6-m Telescope Project Division.

ESO has about 120 international staff members in Europe and Chile and about 150 local staff members in Santiago and on La Silla. In addition, there are a number of fellows and scientific associates.

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