THE IRAQI NATIONAL ASTRONOMICAL OBSERVATORY*

HAMID M. K. AL-NAIMIY
Astronomy and Space Research Center, Jadriyagh, Baghdad, Iraq

(Received 15 May, 1985)

Abstract. Iraq is currently experiencing a praid cultural, scientific, and technical renaissance, and astronomy is a natural focus for the country's pride in the past achievements of the civilization which have flourished in Iraq. The current plans of the Space and Astronomy Research Center (SARC) include building a major observatory to work in the optical, IR and radio region of the spectrum.

The core of the optical facility will be a 3.5 m optical telescope, together with 1.25 m telescope designed for efficient performance in the IR. These telescopes will be equipped with instruments for photographic, photometric and spectroscopic observations. A 30 m dish is also being built for millimeter/radio observations.

SARC has selected an excellent observing site in the northern mountains of Iraq which has good seeing and clear dark skies. The sites selection was made with the collaboration of several leading astronomers and observatories from various countries.

1. Introduction

It is a well-known fact that in the middle ages, the world received important gifts from the Arabs, particularly from Mesopotamia. One of these gifts is the institution which we call today the 'Astronomical Observatory' – a place where groups of astronomers worked together for more than one generation, advancing common goals. In this sense, the concept of on astronomical observatory represents an invention of the Arabs and is one of their permanent contributions to human culture (Kopal, 1983).

We all know that the Babylonians were the first to name the constellations of the Zodiac, and they discovered the Saros period which they measured to be ten years and ten days.

A large number of bright stars and astronomical terms still carry their Arabic names (Abetti, 1952) the terms zenith, nadir, azimuth, alidade, almucanter are only a few examples. Names of stars such as Aldebaran, Betelgeuse, Altair, Algol are also Arabic names.

Several observatories were established in Mesopotamia, the most important are:
- Al Maamouni Observatory,
- Benou Moussa Observatory,
- Samarra Observatory.

Several great astronomers lived in Mesopotamia, one of whom Al-Battani (856–929), latinized Albategnius, carried out observations of remarkable accuracy. He noticed that the longitude of the Sun's apogee had increased by $16°43'$ since the time of Ptolemy, which implies a slow variation in the 'Equation of Time'. He determined the length of

---

* Paper presented at the IAU Third Asian-Pacific Regional Meeting, held in Kyoto, Japan, between 30 September–6 October, 1984

Astrophysics and Space Science **118** (1986) 51–56.

the year to be $365^{d}5^{h}46^{m}24^{s}$ (with an error of $2^{m}23^{s}$).Al-Battani's work in Mesopotamia shows like a star of the first magnitude in the firmament of astronomy, illuminating a way to the future (Kopal, 1983).

With all this in the background, it is not surprising that interest in astronomy is still considered a matter of heritage in Mesopotamia. In fact, a first class observatory is being built in this area.

2. Site Selection

Several expeditions were arranged during the period 1974–1977 to select a suitable site for the observatory. These expeditions were made with help from Soviet, Egyptian, and American Astronomers. Finally, two sites were selected (Table I), and a site testing program started in both sites. The program included the monitoring of meteorological data and seeing measurements using the Polaris Trail Telescope (PTT) method developed by Prof. M. F. Walker from University of California at Santa Cruz. The programme was carried by Iraqi personnel assisted by a group from the Royal Greenwich Observatory (RGO). PTT plates were processed and evaluated by Walker.

TABLE I

	Sinjar	Korek
Altitude	1500 m	2127 m
Longitude	41°45′ E	44°28′ E
Latitude	36°28′ N	36°35′ N

TABLE II

Seeing in sec of arc	≤1″	1.1″–1.5″	1.6″–2″	>2″
Korek	18%	43%	18%	21%
Sinjar	9%	13%	15%	63%

TABLE III

Percentage of observed nights with average seeing as indicated

Location	Best seeing observed	Sec of arc				Total nights
		≤1.0	1.1 to 1.5	1.6 to 2.0	>2.0	
Junipero Serra	0″.5	26	38	13	23	558
Siero Toledo	0″.7	24	32	22	22	509
Korek	0″.5	11	29	23	37	106
Kitt Peak	0″.75	15	30	16	39	253
San Pedro Martir	0″.75	15	25	17	42	2
Piper Mountion	0″.75	9	30	20	42	164
Mt. McKinley	0″.75	2	32	20	46	50
Sinjar	0″.75	1	19	212	59	100
Flagstaff	1″.0	1	5	29	65	80

Table II shows seeing measurements for both sites (October 1977–January 1978). According to these results, Mt. Korek was selected, but site testing continued for a full year (October 1977–August 1978). Results are compared with other international sites (Table III).

3. Iraqi National Astronomical Observatory (INAO)

The INAO project is being built as a West-German joint venture, in a 'Turn-Key' contract, which includes as well civil work and a residential complex. Work started in 1981 and the last section of the project is expected to be finished in 1986. The observatory comprises the following telescopes:

- 30 m Millimeter Radio Telescope (MRT).
- 3.5 m Optical Telescope (LOT)
- 1.25 m Optical Telescope (SOT).

Other astronomical observing equipment is also included in the project.

In what follows, we give a brief description of the system:

(A) Radio telescope

The radio telescope is to be manufactured by Krupp–MAN (Ltd. – of W. Germany) and is designed along the lines of 30 m mm radio-telescope. The telescope design provides for an antenna mounted in an altazimuth system, in accordance with the turning-head principle. It is designed for operation without a radio-dome.

The *reflector surface* is to be constructed in a very special way that will minimize dead weight and thermal deformations in the panel area. The panels are constructed from an aluminium honeycomb sandwich material and are adjusted the workshop in pairs on frames which are fixed to the reflector truss-work.

The reflector panels are constructed with an r.m.s. deviation of <40 μm while the overall surface accuracy is <80 μm. This accuracy is necessary for operation in the millimetre wavelength region.

To minimize thermal effects, a thermal insulation layer is used. This forms the front enclosure of an air-circulation system around the reflector truss-work. This sytem ensures a maximum temperature difference of <1 K.

To minimize gravitational effects the homology principle is utilized, where the structure deforms under gravity at any elevation angle into another parabola, thus minimizing the effect of gravity on surface accuracy.

Working at high frequencies with large aperture puts stringent requirements on the control system, as the beam width of the telescope gets sharper. Pointing and tracking errors are less than 1 arc sec.

Extensive simulation studies proved that a conventional cascaded control system does not meet the high accuracy required, and provides insufficient damping of wind load. A more exact state controller was designed which considerably reduces pointing error.

The telescope is controlled by a VAX 11/780 computer.

(B) RECEIVER SYSTEM

The receiver system is designed and manufactured by MBB. It consists of the following:

(1) *Front end*

The front end allow measurements in the following frequencies:

(i) 4.6 to 5.1 GHz;
(ii) 8.9 to 10.8 GHz;
(iii) 21.8 to 23.8 GHz.

Different operation modes are initiated by a switching network following the antenna feed/polarizer equipment. The switching network is controlled by the measurement control equipment.

Input signal is down-converted to 770 MHz at a bandwidth of 500 MHz for both polarizations. The IF signal is then transmitted to the control and research building.

(2) *Back End*

The back end consists of the following receivers:

(1) *The continuum polarization receiver (CPR)* processes the two polarization channels to output channels enabling the definition of the total power for each channel, and the Stokes parameters.

(ii) *The acousto-optical spectrometer (AOS)* allows spectral measurement of radio sources. The AOS allows the monitoring of 1024 channels of 500 MHz total bandwidth, with overlapping single channel bandwidths of 0.7 MHz.

(iii) *The auto-correlation spectrometer (ACS)* measures the autocorrelation function of the received signal, which is then Fourier transformed into the power spectrum. The ACS allows a maximum of 1024 channels with a channel bandwidth of 48 Hz–195 KHz selectable by the user.

(3) *Receiver System Control*

Data collection and analysis is done by a second VAX 11/780 computer.

(C) 3.5 m OPTICAL TELESCOPE (LOT)

The 3.5 m optical telescope is designed after the Max-Planck-Institute telescope at Calar Alto and will be manufactured by Zeiss. The telescope mounting is an equatorial horseshoe frame, similar to the 5 m telescope of Mt. Palomar. The telescope tube is of Serrurier type. The hour axis is driven by a single-stage spur gear at the large diameter of the horse-shoe. Eight motors are used for hour drive.

The telescope utilizes the $F/3$ prime focus, the $F/10$ Ritchey–Chrétien (RC) focus, the $F/35$ coudé focus, and an $F/35$ wobbling IR focus. It is controlled by two computers (PDP) 11/44 and PDP 11/24). It is also equipped with a 35 cm guiding telescope, a TV offset guider and TV control equipment which allow automatic guiding and remote operation at the different foci.

The telescope is provided with the following astronomical equipment:

(1) *Prime focus attachment (PFA)* is provided with a 24 × 24 cm photographic attachment which can be used with 2-lens and 3-lens correctors. Remote control and TV monitoring allows unmanned operation. A detachable cabin is also provided for manual operation.

(2) *Cassegrain spectrograph* of Boller and Chivens type 31523 is also provided, which allows dispersions in the range of 40–550 Å mm^{-1}. The spectrograph has six interchangeable gratings and is provided with an image intensification tube.

(3) *Coudé echelle spectrograph (CES)* is designed according to the white pupil principle, which allows a compact system. The spectrograph is provided with two echelle gratings 79 lines/mm and 316 lines/mm blazed at 63°.

One $F/3$ Schmidt-meniscus Cassegrain camera is provided for recording echellograms. This camera is equipped with two interchangeable cross-dispersers. In addition $F/1$ and $F/1.5$ cameras are provided for recording single-order spectra.

(D) 1.25 m OPTICAL TELESCOPE (SOT)

This telescope will also be manufactured by Zeiss and is designed after the 1.23 m telescope of Max-Planck-Institute at Calar Alto. The telescope mounting is a pole – universal type where the entire weight of the telescope floats on a spherical oil bearing. The telescope drive is controlled by two computers (PDP 11/34 – PDP 11/24).

The telescope has three foci, $F/10$ RC-Cassegrain, $F/10$ Nasmyth, and $F/35$ IR cassegrain focus. It is also provided with a 35 cm guiding telescope, TV offset guider, and TV control equipment. The telescope is provided with a fixed Nasmyth Spectrograph similar to the LOT Cassegrain Spectrograph.

(E) ADDITIONAL INSTRUMENTS

In addition to the equipment listed with each telescope, there is equipment that can be used for observations on both telescopes as follows:

(1) *UBVRI photometer* which will be used for singe-channel photometry in the five spectral bands. The photometer is equipped with two interchangeable photomultipliers for photon counting and DC-mode observations.

An LSI 11/2 computer is used for photometer control and data acquisition. The photometer has been developed by the Max-Planck-Institute at Heidelberg.

(2) *Two infrared photometer/spectrophotometers* are provided, one for the 1–5 μm spectral region and the other for the 5–14 μm region. Both photometers are identical, except for filters and detectors. Both photometers are equipped with advanced detectors and sophisticated data acquisition systems which allow background-sky limited operation.

Each photometer is cooled by two-stage closed cycle cryogenic cooling system.

Each photometer is controlled by PDP 11/23 computer which also controls the lock-in amplifier and allows automatic observation.

The photometer is provided with eight filters at selected bands and a circular variable filter (CVF) for spectrometric purposes.

The photometer control can be synchronized with telescope motion to allow automatic beam switching, raster scan and search scan.

(3) Data reduction facilities include:

(a) Perkin Elmer PDS micro 10 microdensitometer.

(b) PDP 11/44 computer.

References

Abetti, G.: 1952, *The History of Astronomy,* Henry Schuman, New York.

Kopal, Z.: 1983, in K. Goffstein (ed.), 'The Role of Astronomy in Islamic Culture', *Islamic Cultural Identity*, Nomos Verlag.