

A BRIEF HISTORY OF ASTRONOMY

PREHISTORIC PERIOD (BEFORE 500 BC)



RING OF STONES
IN SOUTHERN SAHARA
DESERT (6,000 TO
6,500 YEARS OLD)



LOCATION



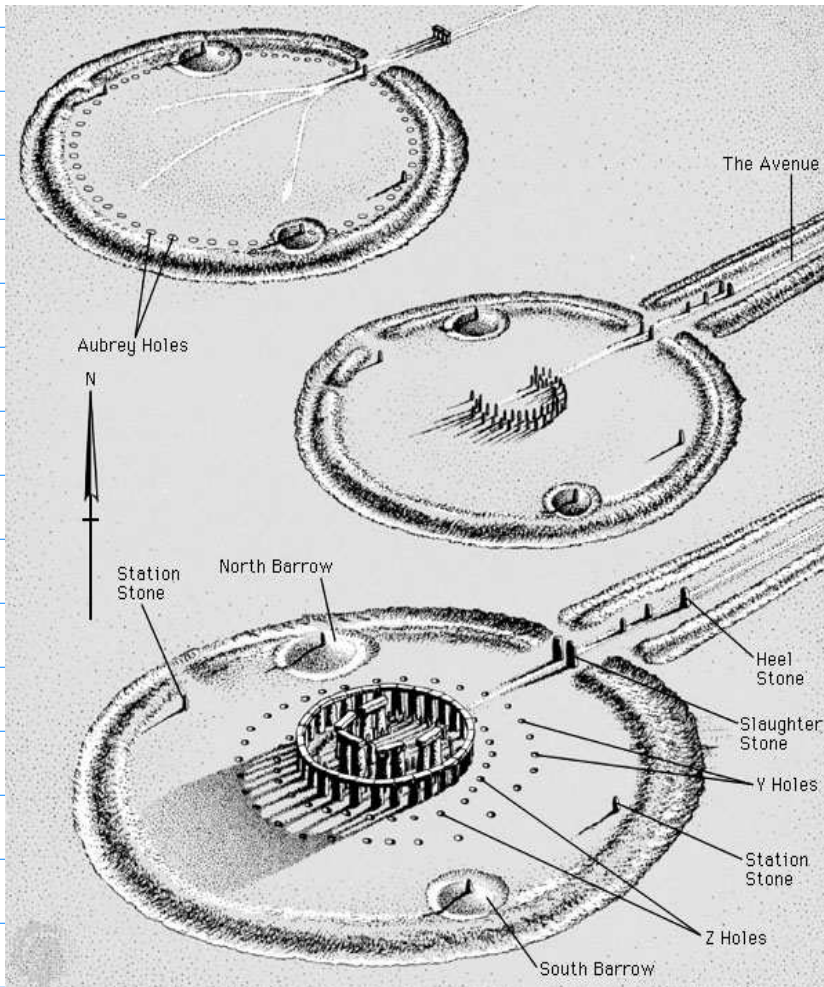
THE RING OF BRODGAR
(2,500 – 2,000 BC)
IN THE ORKNEY
ISLANDS, SCOTTLAND



LOCATION: MAINLAND



STONEHENGE, AT SALISBURY PLAIN, ENGLAND



IT WAS BUILT
IN SEVERAL STAGES
FROM ABOUT 2900 BC
TO ABOUT 1600 BC



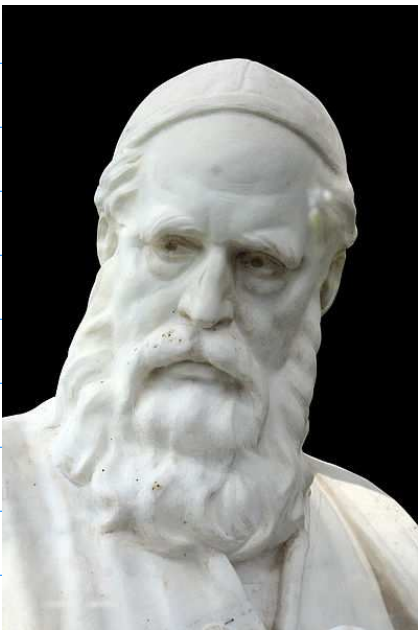
THE GREAT
PYRAMID OF
GIZA, EGYPT
(ABOUT 2500 BC)

ALL OF THESE MONUMENTS HAVE SOME ASTRONOMICAL ALIGNMENTS, BUT THEIR TRUE PURPOSE IS NOT KNOWN.

IN THE PREHISTORIC PERIOD THE MOTIONS OF THE STARS, THE SUN, THE MOON, AND THE PLANETS WERE LIKELY TRACKED AS A FORM OF WORSHIP AND DIVINATION. DIFFERENT CULTURES FROM THAT PERIOD MIGHT HAVE USED THE MONUMENTS TO KEEP TRACK OF THE SEASONS (A MATTER OF LIFE AND DEATH!)

CLASSICAL PERIOD (FROM 500 BC TO 1400 AD)

WE FOCUS ON THE ASTRONOMY OF GREECE (INFLUENCED BY ASTRONOMY OF BABYLONIA AND EGYPT). THE CHINESE, INDIAN AND ISLAMIC ASTRONOMERS ALSO MADE IMPORTANT CONTRIBUTIONS. FOR EXAMPLE, IN 1079 AD PERSIAN POET, MATHEMATICIAN AND ASTRONOMER OMAR KHAYYAM DETERMINED



THE LENGTH OF TROPICAL YEAR - THE PERIOD FROM ONE VERNAL EQUINOX TO THE NEXT ONE - TO 14 SIGNIFICANT FIGURES (HE OBTAINED 365.24219... DAYS AND THE MODERN VALUE IS 365.242189).

SOME NOTABLE GREEK THINKERS AND ASTRONOMERS:



THALES OF MILETUS
(624-546 BC):

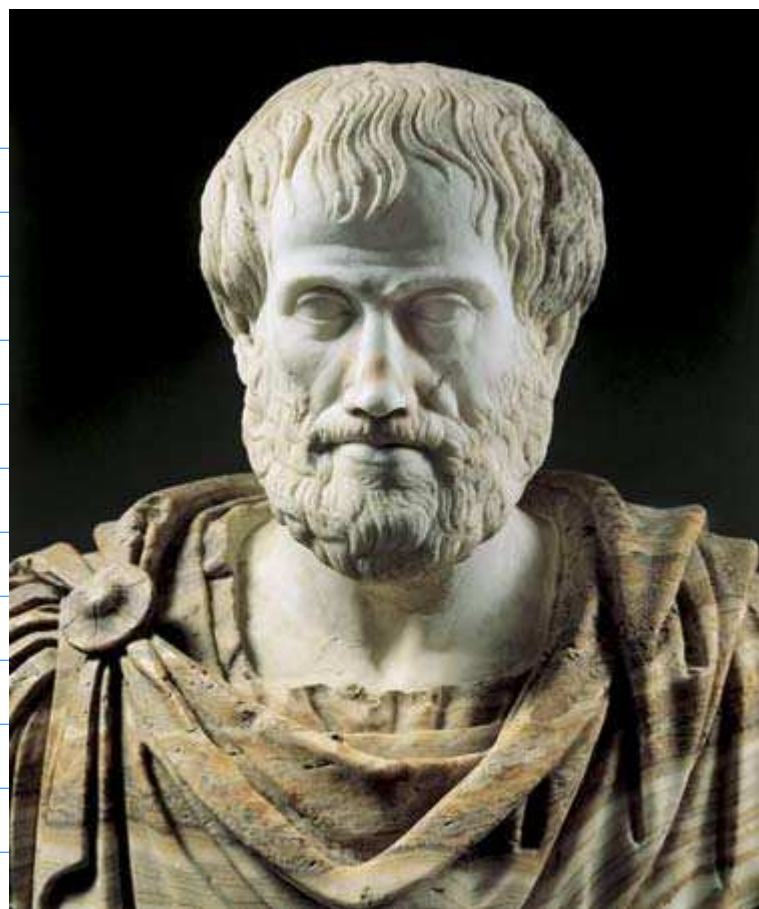
HUMAN MIND CAN UNDERSTAND
WHY THE UNIVERSE WORKS
THE WAY IT DOES.



PYTHAGORAS
(560-480 BC):

MANY THINGS IN
NATURE SEEM TO
BE GOVERNED BY
GEOMETRICAL AND
MATHEMATICAL
RELATIONS.

FROM RAFAEL'S FRESCO
SCHOOL OF ATHENS



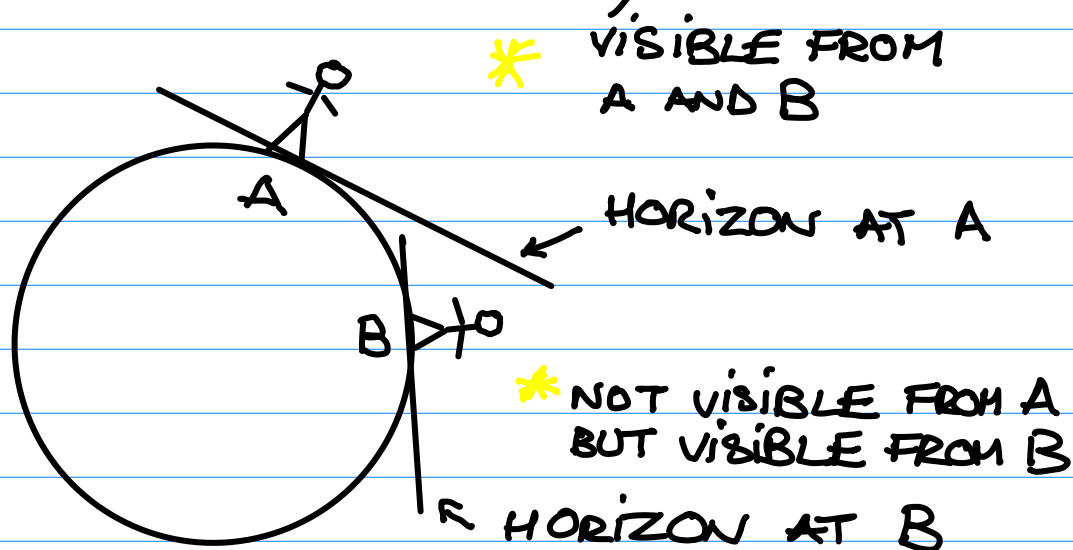
ARISTOTLE (384-322 BC)

HE WAS THE MOST INFLUENTIAL ANCIENT PHILOSOPHER OF NATURAL WORLD:

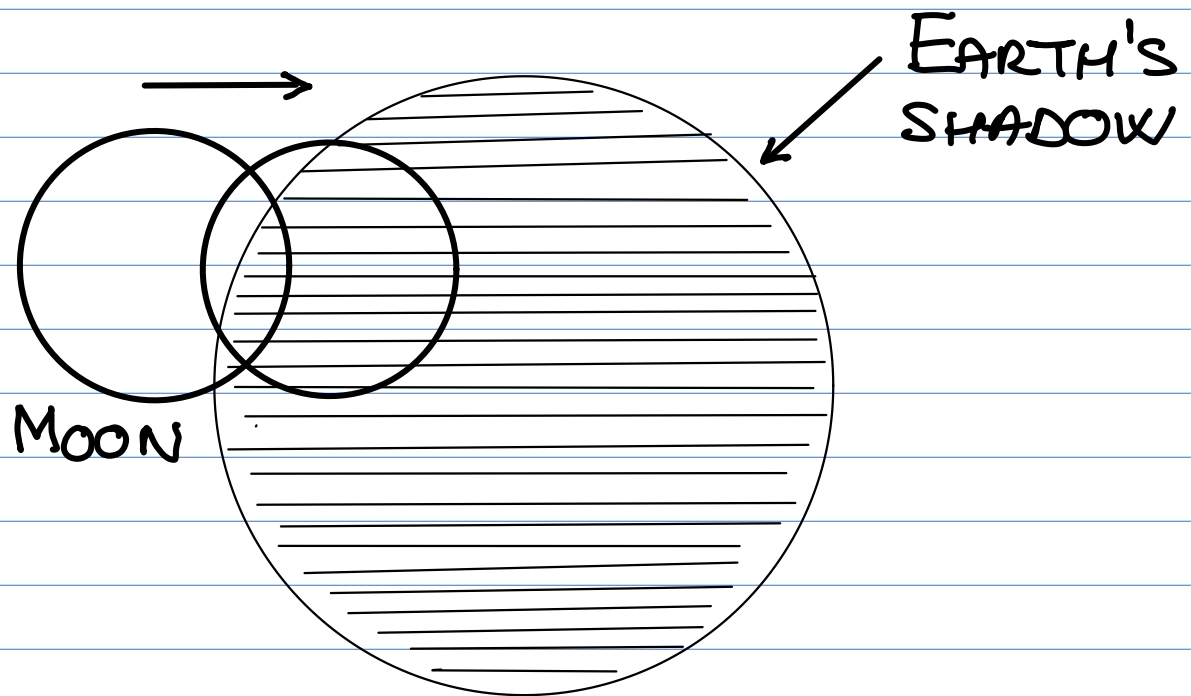
HE ARGUED THAT THE EARTH WAS THE CENTER OF THE UNIVERSE (GEOCENTRIC MODEL).

ARISTOTLE USED OBSERVATIONS TO DEDUCE THAT THE EARTH MUST HAVE SPHERICAL SHAPE:

1) TRAVELING SOUTH ONE STARTS SEEING STARS THAT WERE PREVIOUSLY HIDDEN



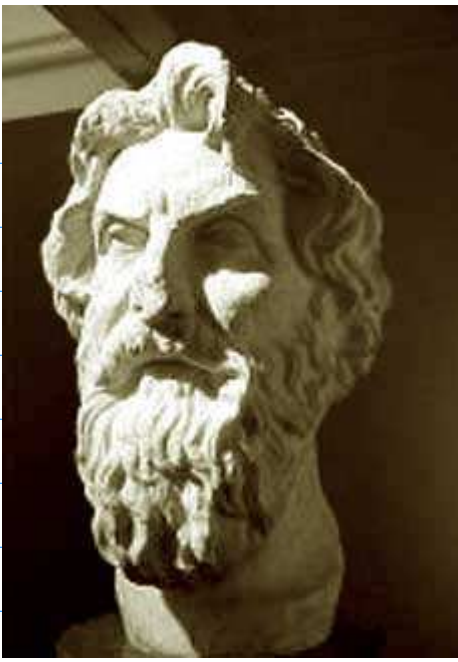
2) DURING A LUNAR ECLIPSE THE EARTH'S SHADOW IS ALWAYS CIRCULAR:



3)



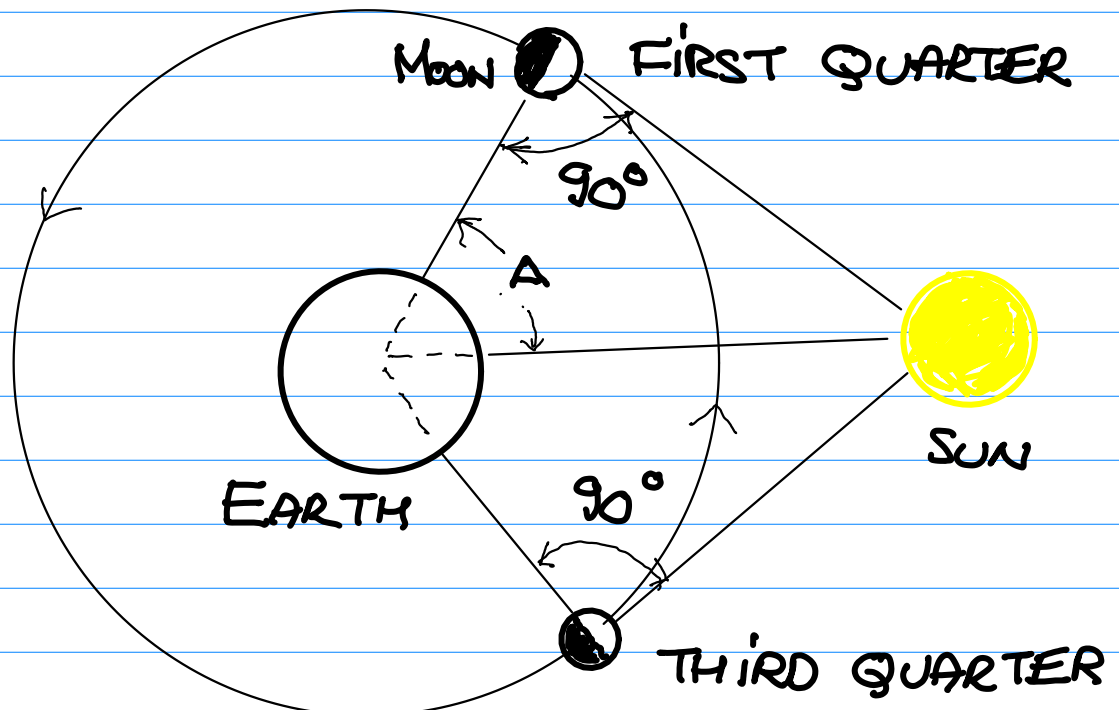
AS A DISTANT SHIP ON THE HORIZON IS APPROACHING WE SEE MORE AND MORE OF IT.



ARISTARCHUS OF SAMOS (C. 310 - 230 BC)

HE USED OBSERVATIONS AND GEOMETRY TO PROPOSE THAT THE EARTH ROTATED ON ITS AXIS AND THAT IT REVOLVED AROUND THE SUN (HELIOCENTRIC MODEL).

- 1) THE DISTANCE TO THE SUN MUST BE MUCH GREATER THAN THE DISTANCE TO THE MOON. IF THE TWO DISTANCES WERE COMPARABLE THEN



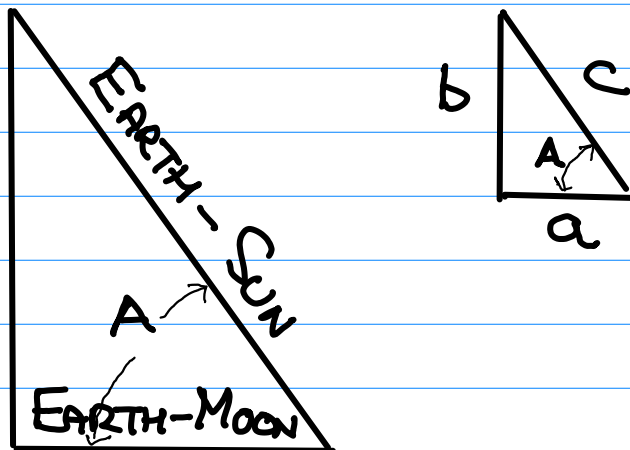
AND THE INTERVAL OF TIME FROM FIRST QUARTER TO THIRD QUARTER WOULD BE LONGER THAN THE INTERVAL OF TIME FROM THIRD QUARTER TO FIRST QUARTER (ASSUMING THAT THE MOON REVOLVES AT A CONSTANT SPEED). BUT THESE TWO INTERVALS OF TIME ARE NEARLY THE SAME (ABOUT TWO WEEKS).

FOR THESE TWO INTERVALS TO BE ALMOST EQUAL THE EARTH-SUN DISTANCE MUST BE MUCH GREATER THAN THE EARTH-MOON DISTANCE.

HE MEASURED THE ANGLE A AND DETERMINED THE RATIO

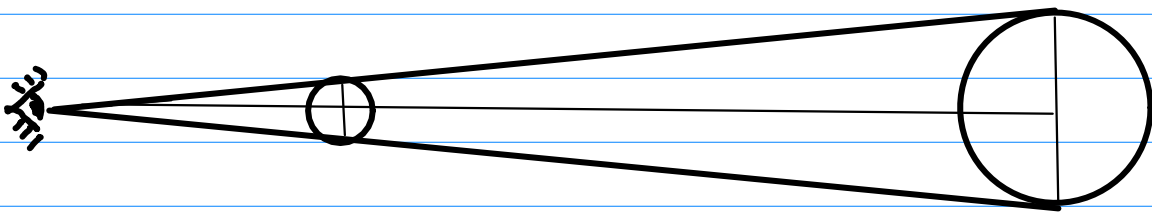
$$\frac{\text{EARTH-MOON DISTANCE}}{\text{EARTH-SUN DISTANCE}} = \frac{a}{c}$$

USING SIMILAR TRIANGLES



HE MEASURED $A = 87^\circ$ (THE ACTUAL VALUE IS $A = 89^\circ$ AND 59 MINUTES) AND OBTAINED FOR THE RATIO OF DISTANCES $1/20$, WHICH IS TOO BIG AS THE ACTUAL VALUE IS $384,500 \text{ km} / 150,000,000 \text{ km} \approx 1/400$.

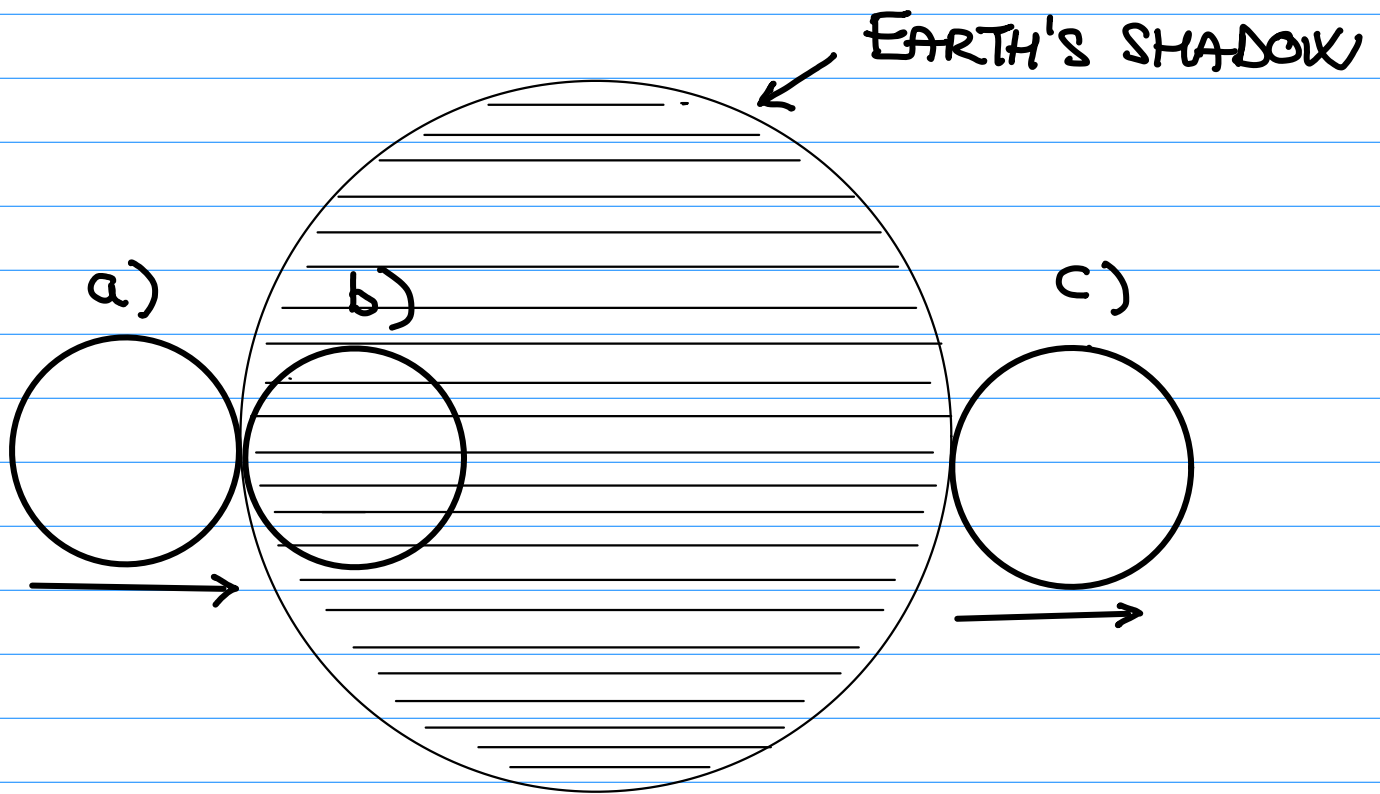
2) SINCE THE SUN AND THE MOON HAVE THE SAME ANGULAR SIZE (ABOUT 0.5°) ARISTARCHUS COULD DETERMINE THE RATIO OF THEIR DIAMETERS FROM THE KNOWN RATIO OF THEIR DISTANCES USING SIMILAR TRIANGLES



$$\frac{\text{DIAMETER OF THE MOON}}{\text{DIAMETER OF THE SUN}} = \frac{\text{DISTANCE TO THE MOON}}{\text{DISTANCE TO THE SUN}} = \frac{1}{20}$$

(THE ACTUAL VALUE IS $1/400$).

3) ARISTARCHUS DETERMINED THE RELATIVE SIZE OF THE EARTH AND THE MOON BY TIMING THE LUNAR ECLIPSE:



THE TIME TO GET FROM a) TO b) IS PROPORTIONAL TO THE DIAMETER OF THE MOON.

THE TIME TO GET FROM b) TO c) IS PROPORTIONAL TO THE DIAMETER OF THE EARTH.

THUS,

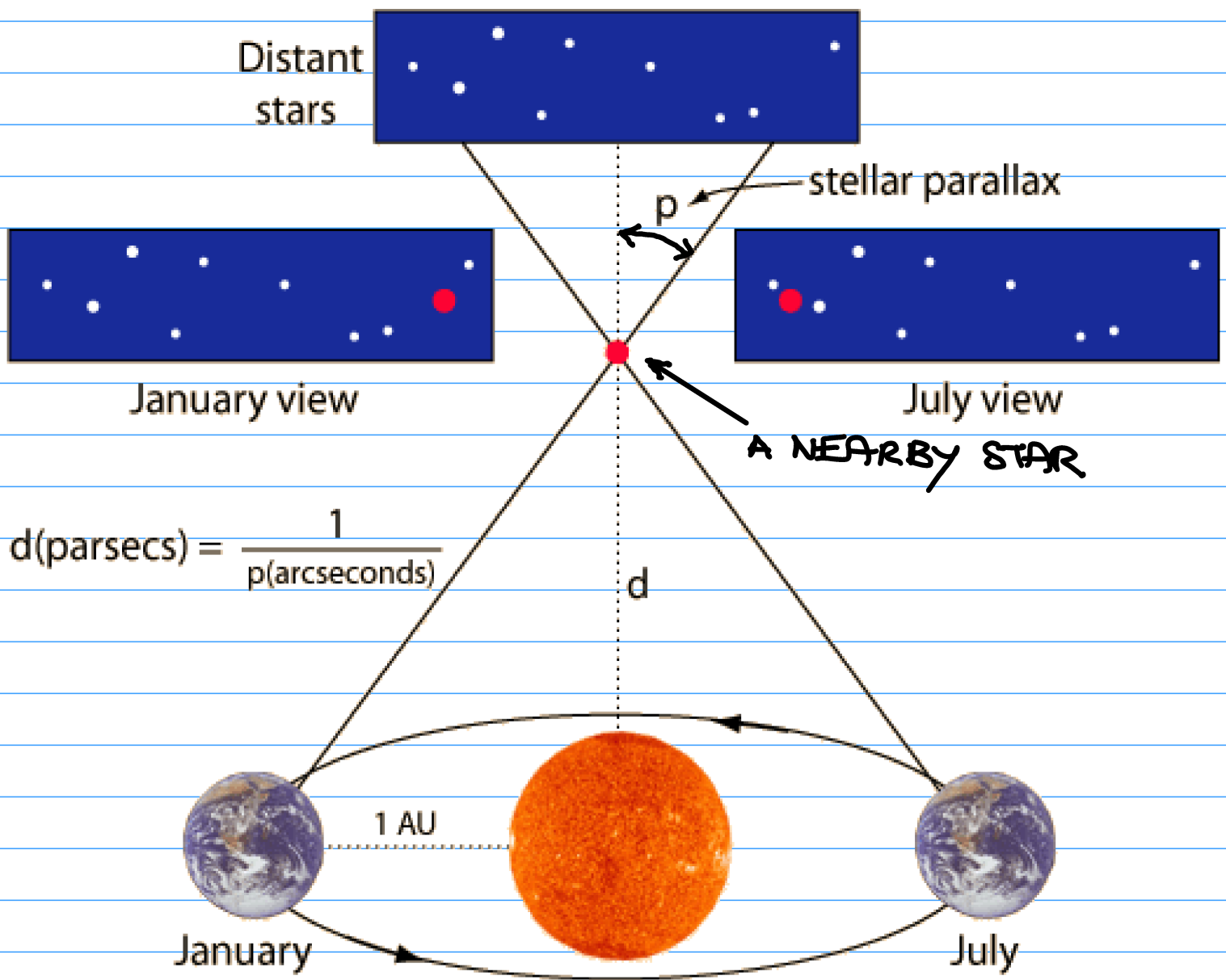
$$\frac{\text{TIME FROM a) TO b)}}{\text{TIME FROM b) TO c)}} = \frac{\text{DIAMETER OF THE MOON}}{\text{DIAMETER OF THE EARTH}}$$

ARISTARCHUS OBTAINED FOR THIS RATIO A VALUE 0.35 (THE ACTUAL VALUE IS 0.27).

IF THE SUN IS 20 TIMES BIGGER THAN THE MOON, AND THE EARTH IS $1/0.35 = 2.86$ TIMES BIGGER THAN THE MOON, THEN THE SUN IS $20 \times 0.35 = 7$ TIMES BIGGER THAN THE EARTH.

ARISTARCHUS ARGUED THAT IT IS NOT REASONABLE THAT A BODY 7 TIMES BIGGER THAN THE EARTH AND 20 TIMES MORE DISTANT THAN THE MOON COULD BE MOVING SO FAST THAT IT REVOLVES AROUND THE EARTH ONCE IN 24 HOURS. INSTEAD, HE PROPOSED THAT THE EARTH AND OTHER PLANETS REVOLVE AROUND SUN (THE HELIOCENTRIC MODEL).

THE MAIN OBJECTION TO HELIOCENTRIC MODEL WAS THAT NO STELLAR PARALLAX WAS OBSERVED (AT THAT TIME AND UP TO 1838):

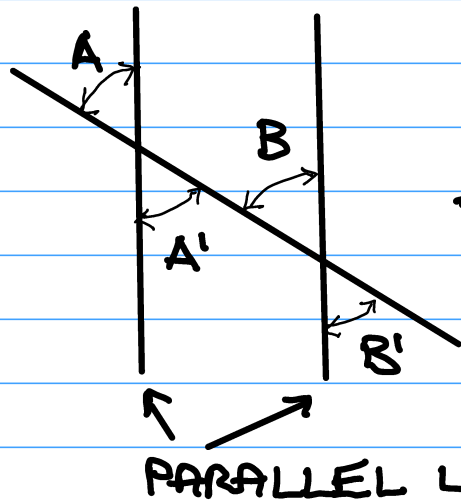


EVEN FOR THE CLOSEST STAR (PROXIMA CENTAURI) THE PARALLAX ANGLE IS LESS THEN 1 SECOND OF ARC $= 1/3600^\circ$ AND IS HARD TO MEASURE.



ERATHOSTENES OF CYRENE
(275 - 194 BC): HE DETERMINED
THE RADIUS/CIRCUMFERENCE
OF THE EARTH (AROUND
240° BC) USING OBSERVATIONS
AND GEOMETRY:

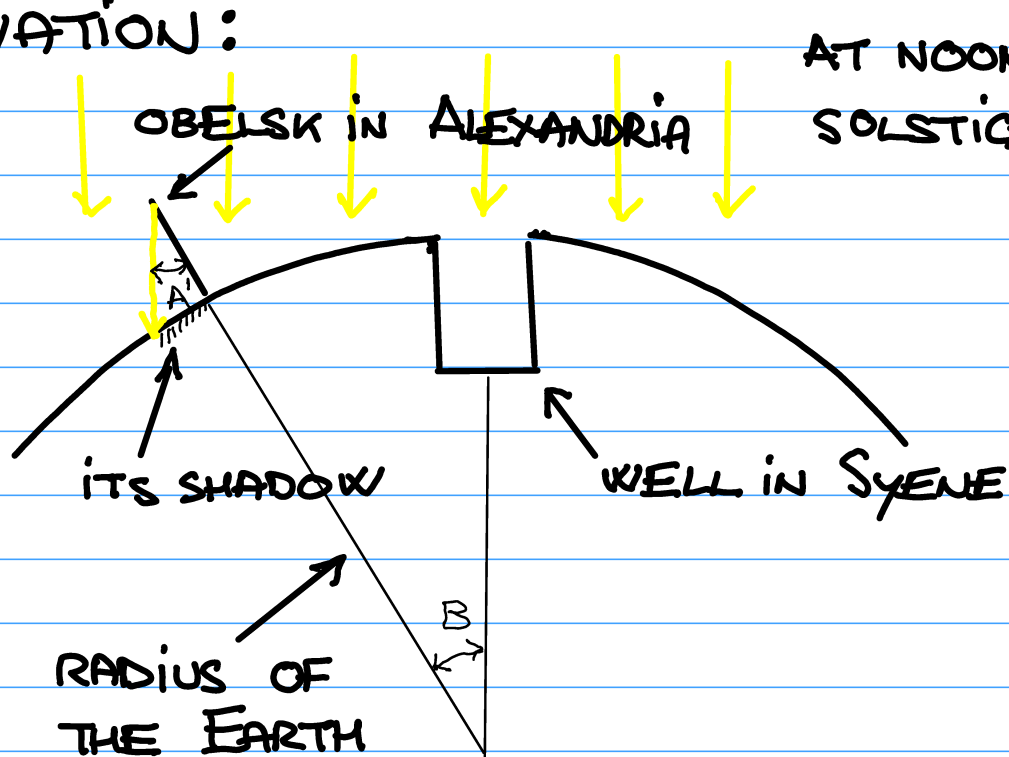
GEOMETRY:



ANGLES A, A', B, B'
ARE THE SAME

PARALLEL LINES

OBSERVATION:



AT NOON ON SUMMER
SOLSTICE

WHEN ANGLE $A' = B$ IS SMALL THEN

$$\frac{\text{RADIUS OF THE EARTH}}{\text{OBELISK-WELL DISTANCE}} = \frac{\text{HEIGHT OF THE OBELISK}}{\text{LENGTH OF ITS SHADOW}}$$

DEDUCE

MEASURE

THE VALUE THAT ERATOSTHENES OBTAINED FOR THE RADIUS OF THE EARTH R (THE CIRCUMFERENCE IS $2\pi R$) IS CLOSE TO THE CURRENT VALUE.

MOTION OF PLANETS:

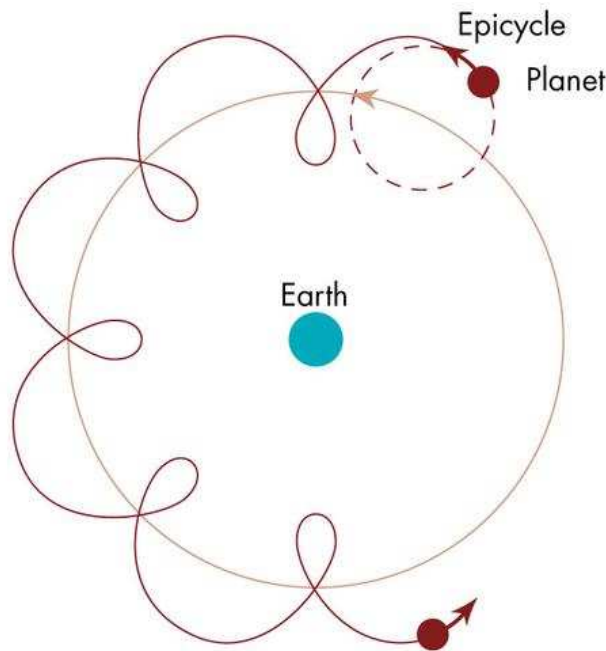
THE RETROGRADE MOTION OF MARS AND URANUS IN 2003



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UNLIKE THE MOTION OF THE STARS THE MOTIONS OF PLANETS ARE NOT CYCLIC. GENERALLY IT IS EASTWARD (LIKE THE SUN) BUT EVERY NOW AND THEN THEY REVERSE DIRECTION (PLANETAI IN GREEK MEANS WANDERERS).

TO ACCOUNT FOR THIS WITHIN A GEOCENTRIC MODEL THE GREEKS INVENTED THE EPICYCLES:



THE SYSTEM WITH EPICYCLES WAS PERFECTED BY PTOLEMY (100-170 AD).