



EYES, MATH, AND MEASUREMENT SUFFICED TO FIND HEAVENLY REGULARITIES SO PRECISE THAT ASTRONOMERS GAINED A CRITICAL ROLE IN THE ANCIENT STATE.

THE RISING SUN BLUSHES THE BUTTOCKS OF BAAL! QUARTERLY TAXES ARE DUE!

YOU ARE TRULY INDISPENSABLE...

IN FACT, ASTRONOMERS WERE FINE WITH THEIR EYES FOR A FULL SIX CENTURIES AFTER AL-HAYTHAM DESCRIBED LENSES IN HIS "OPTICS."

AHEM AHEM! LOOK DOWN!

IN SEPTEMBER 1608, A DUTCH OPTICIAN NAMED HANS LIPPERSHEY PRESENTED HIS PRINCE WITH A GADGET: TWO LENSES MOUNTED AT EITHER END OF A TUBE.

I SEE NATIONAL SECURITY IMPLICATIONS!



LIPPERSHEY PROSPERED, SO NATURALLY HIS LENS-GRINDING NEIGHBOR ZACHARIAS JANSSEN CLAIMED PRIORITY.

I'LL TAKE 50 OF 'EM!

OF MINE! OF MINE!



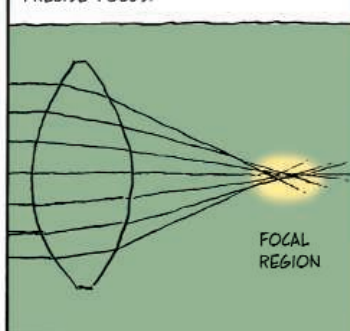
AT THE TIME, HELIOCENTRISM WAS ROILING SCIENCE, SO GALILEO QUICKLY KNOCKED OFF A COPY AND POINTED IT UPWARD, WITH FAMOUS RESULTS.



KEPLER SUGGESTED MOUNTING A CONVEX EYEPIECE BEHIND THE PRIMARY'S FOCUS, FOR POTENTIALLY GREATER MAGNIFICATION (BUT AN UPSIDE-DOWN IMAGE).



BIGGER, BUT BLURRY: SPHERICALLY CURVED LENSES—THE SHAPE GENERALLY GROUND AT THE TIME—LACK A PRECISE FOCUS.



BESIDES, ANY SIMPLE LENS ACTS AS A PRISM, PRODUCING RAINBOW FRINGES OR "CHROMATIC ABERRATION."

HOW SAD... I THOUGHT PLANETS HAD HALOS...



ASTRONOMERS MINIMIZED THESE ABERRATIONS BY USING LOW-CURVATURE LENSES...

WHERE DO YOU WANT THE NEW 'SCOPE?

OVER THERE IS FINE...

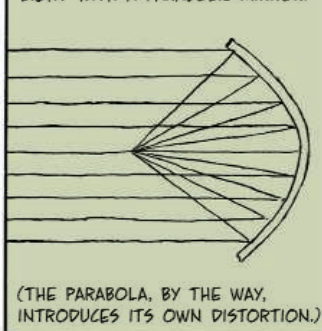


... WHOSE IMMENSE FOCAL LENGTHS RESULTED IN VERY UNWIELDY INSTRUMENTS. HUYGENS BUILT ONE 37 METERS LONG...

OR MAYBE HERE IS BETTER... WAIT... HOW ABOUT HERE? NO...



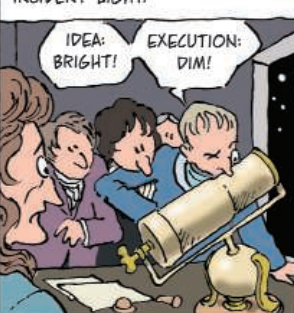
IN 1663, A REFLECTIVE SCOT, JAMES GREGORY, PROPOSED TO ELIMINATE BOTH PROBLEMS BY FOCUSING LIGHT WITH A PARABOLIC MIRROR.



GREGORY FUMBLERED HIS COMPLEX DESIGN, BUT IN 1668 ISAAC NEWTON BUILT A SIMPLER WORKING REFLECTOR (WITH A SPHERICAL MIRROR, THE BEST HE COULD DO): 40 POWER AND ONLY 15 CM LONG!



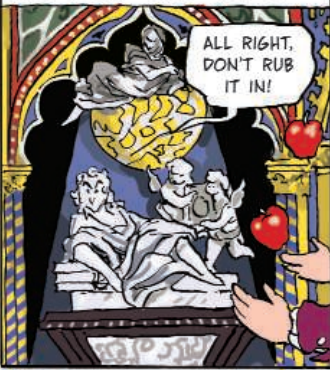
NEWTON'S SECOND, LARGER REFLECTOR, LIKE THE FIRST, HAD A POLISHED METAL MIRROR THAT ABSORBED SOME 80% OF THE INCIDENT LIGHT.



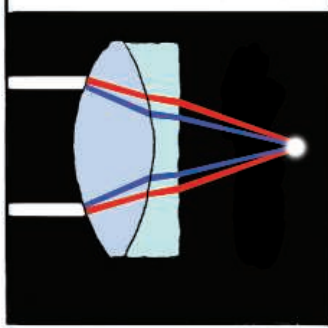
STILL, HE HAD HOPES FOR REFLECTORS. CHROMATIC ABERRATION, HE BELIEVED, WOULD FOREVER AFFLICT EVERY LENS.



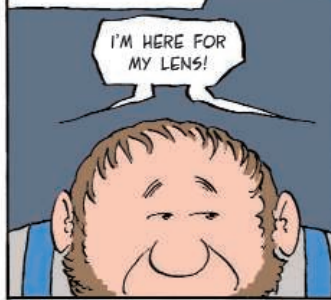
IN 1733, MATHEMATICIAN CHESTER HALL PROVED NEWTON WRONG.



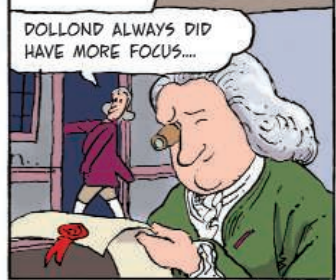
HALL'S IDEA: ABOUT TWO LENSES OF DIFFERENT REFRACTIVE INDICES. ONE WOULD UNBEND THE CHROMATIC ABERRATION OF THE OTHER.



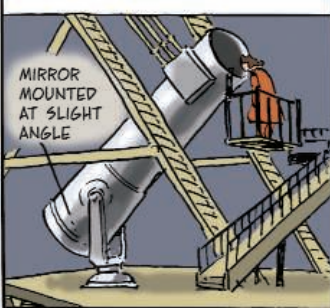
TO MASK HIS PLAN, HE HIRED TWO OPTICIANS, ONE FOR EACH LENS... BUT THEY BOTH USED THE SAME SUBCONTRACTOR, GEORGE BASS, AND BASS BLABBERED.



HALL MOVED ON AND LEFT MASTER GRINDER JOHN DOLLOND TO PERFECT AND PATENT COMPOUND LENSES THAT ALL BUT ELIMINATED BOTH CHROMATIC AND SPHERICAL ABERRATION.



MIRROR SHAPING IMPROVED TOO. IN THE 1770S AND '80S, WILLIAM HERSCHEL MADE BIG REFLECTORS, EACH WITH A PARABOLIC MIRROR VIEWED FROM THE LIP OF THE TELESCOPE.



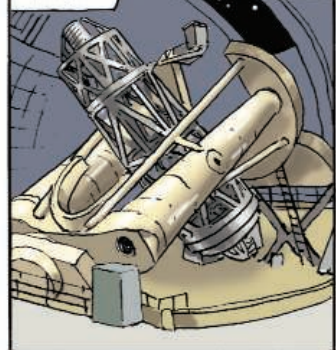
DESPITE SOME FINE REFRACTORS, THE FUTURE CLEARLY LAY WITH BIG REFLECTORS, THOUGH MAYBE NOT LORD ROSSE'S 1847 LEVIATHAN, STUPIDLY SITED IN MISTY IRELAND.



1917: THE GREAT 254-CM MT. WILSON REFLECTOR OPENED ITS EYE—UPON WHICH, ITS OBSESSIVE DESIGNER GEORGE HALE CHECKED INTO AN ASYLUM WITH AN IMAGINARY GREEN FRIEND...



AND FINALLY MT. PALOMAR'S MONSTER, WITH ITS 5-METER, 12-TON MIRROR.



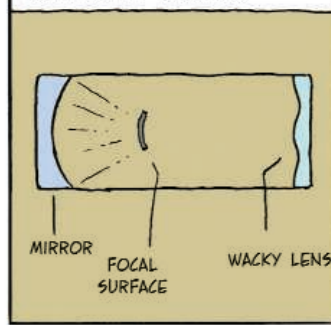
AND THEN WHAT? THESE GIANTS HAD LIMITS: THEIR NARROW FIELD OF VIEW HAMPERED SKY MAPPING... AND THEY HAD TO PEER THROUGH A FUZZY, FLUID BLANKET OF AIR LIKE EVERYONE ELSE.



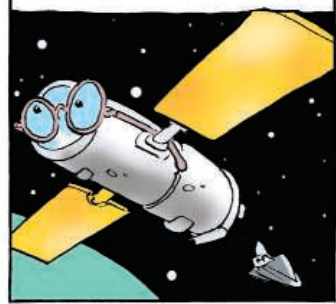
IN THE 1920S, BERNHARD SCHMIDT SOLVED THE WIDE-ANGLE PROBLEM WITH VAST CALCULATIONS, ALL BY HAND (NOT SO EASY, SINCE HE HAD BLOWN OFF HIS HAND IN A YOUTHFUL EXPERIMENT)...



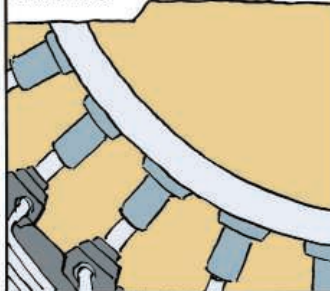
A SCHMIDT TELESCOPE USES A SPHERICAL MIRROR CORRECTED BY A WACKY LENS THAT DELIVERS NEAR-PERFECT GEOMETRY.



NOW ZIP AHEAD TO COMPUTERS AND ROCKETS... THE HUBBLE HURDLES THE ATMOSPHERE... CLEAR IMAGES AT LAST (ONCE THE ORIGINAL FAULTY OPTICS WERE FIXED)!



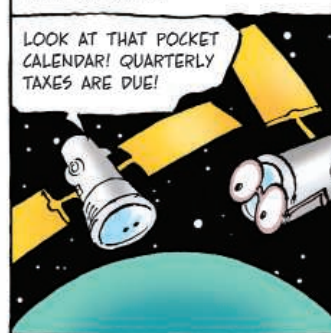
BIG TERRESTRIAL REFLECTORS NOW USE MULTIPLE MIRROR SEGMENTS: THIN, NEARLY FLOPPY THINGS SUPPORTED BY COMPUTER-CONTROLLED LIFTERS THAT MAINTAIN PERFECT CURVATURE.



COMPUTERS CAN EVEN TWEAK SECONDARY MIRRORS TO "DETWINKLE" THE EFFECT OF AIR TURBULENCE IN REAL TIME, FOR IMAGES NEARLY AS CRISP AS THE HUBBLE'S.



OF COURSE, NO GROUND-BASED TELESCOPE CAN COMPETE WITH THE NUMEROUS ORBITING EYES POINTING DOWN.



WHO KNOWS WHAT THE FUTURE MAY BRING? DON'T ASK US... THIS IS A HISTORY, NOT A PREDICTION!



CREDIT: ASTRONOMER WILLIAM ALSCHULER TEACHES AT CAL ARTS; HE GROUND HIS FIRST TELESCOPE LENS IN 8TH GRADE