

EYES, MATH, AND MEASUREMENT SUF-FICED TO FIND HEAVENLY REGULARI-TIES SO PRECISE THAT ASTRONOMERS GAINED A CRITICAL ROLE IN THE ANCIENT STATE.



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



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



LIPPERSHEY PROSPERED, SO NATU-RALLY HIS LENS-GRINDING NEIGH-BOR ZACHARIAS JANSSEN CLAIMED PRIORITY.



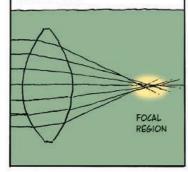
AT THE TIME, HELIOCENTRISM WAS ROILING SCIENCE, SO GALILEO QUICKLY KNOCKED OFF A COPY AND POINTED IT UPWARD, WITH FAMOUS RESULTS.



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



BIGGER, BUT BLURRY: SPHERICALLY CURVED LENSES-THE SHAPE GENER-ALLY GROUND AT THE TIME-LACK A PRECISE FOCUS.



BESIDES, ANY SIMPLE LENS ACTS AS A PRISM, PRODUCING RAIN-BOW FRINGES OR "CHROMATIC ARERRATION.



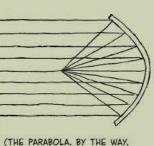
ASTRONOMERS MINIMIZED THESE ABERRATIONS BY USING LOW-CURVATURE LENSES ...



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



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



INTRODUCES ITS OWN DISTORTION.)

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



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



STILL, HE HAD HOPES FOR REFLEC-TORS. CHROMATIC ABERRATION, HE BELIEVED, WOULD FOREVER AFFLICT EVERY LENS



OR CO-AUTHOR OF MANY CARTOON HISTORIES AUTHOR 13 **GONICK** LARRY WRITER/ILLUSTRATOR

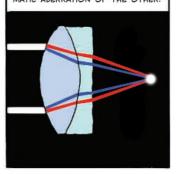
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SCIENCE

IN 1733, MATHEMATICIAN CHESTER HALL PROVED NEWTON WRONG.



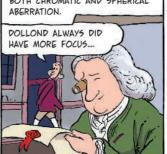
HALL'S IDEA: ABUT TWO LENSES OF DIFFERENT REFRACTIVE INDICES, ONE WOULD UNBEND THE CHRO-MATIC ABERRATION OF THE OTHER.



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



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 17705 AND '805, 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,



1917: THE GREAT 254-CM MT. WIL-50N REFLECTOR OPENED ITS EYE-UPON WHICH, ITS 085E55IVE DESIGNER GEORGE HALE CHECKED INTO AN ASYLUM WITH AN IMAGI-NARY GREEN FRIEND...



AND FINALLY MT. PALOMAR'S MON-STER, WITH ITS 5-METER, 12-TON



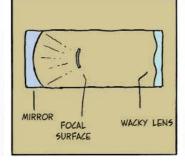
AND THEN WHAT? THESE GIANTS HAD LIMITS: THEIR NARROW FIELD OF VIEW HAMPERED SKY MAPPING... AND THEY HAD TO PEER THROUGH A FUZZY, FLUID BLANKET OF AIR LIKE EVERYONE ELSE.



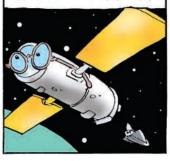
IN THE 19205, BERNHARD SCHMIDT SOLVED THE WIDE-ANGLE PROBLEM WITH VAST CALCULATIONS, ALL BY HAND (NOT SO EASY, SINCE HE HAD BLOWN OFF HIS HAND IN A YOUTHFUL EXPERIMENT)...



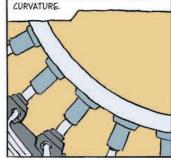
A SCHMIDT TELESCOPE USES A SPHERICAL MIRROR CORRECTED BY A WACKY LENS THAT DELIVERS NEAR-PERFECT GEOMETRY.



NOW ZIP AHEAD TO COMPUTERS AND ROCKETS... THE HUBBLE HUR-DLES THE ATMOSPHERE... CLEAR IMAGES AT LAST (ONCE THE ORIGI-NAL FAULTY OPTICS WERE FIXED)!



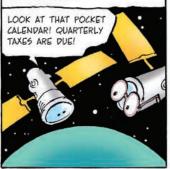
BIG TERRESTRIAL REFLECTORS NOW USE MULTIPLE MIRROR SEGMENTS: THIN, NEARLY FLOPPY THINGS SUP-PORTED BY COMPUTER-CONTROLLED LIFTERS THAT MAINTAIN PERFECT



COMPUTERS CAN EVEN TWEAK SEC-ONDARY 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!



GRADE