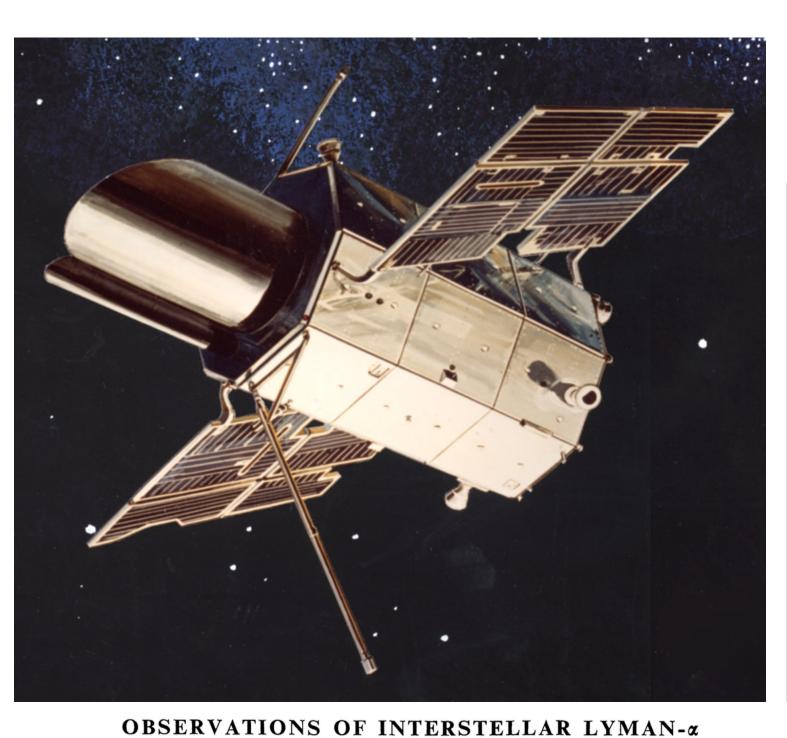
Historical Celebration – 1968 – 1977 – 60 yrs UV Astronomy

1972

Stargazer OAO-2 Code-PI Wisc Exp Package, Wipple-PI 1970 High Res THE ASTROPHYSICAL JOURNAL, 161: L81-L85, August 1970 © 1970. The University of Chicago. All rights reserved. Printed in U.S.A. Telescopes ROCKET OBSERVATION OF INTERSTELLAR

1968



Dec. 1968

WITH THE ORBITING ASTRONOMICAL OBSERVATORY

B. D. SAVAGE and A. D. CODE

Space Astronomy Laboratory, Washburn Observatory University of Wisconsin, Madison, Wis., U.S.A.

Abstract. The equivalent width of the blended line at Lyman α is given for 48 stars measured with the OAO-A2 scanning spectrometer. This provides an upper limit to the neutral hydrogen column density. In the Orion association these upper limits are significantly lower than the column densities determined from 21-cm emission line measurements. The determination of the Lyman α equivalent width for θ Ori by Carruthers is rediscussed and agreement between 21-cm absorption measures and Lyman α absorption is obtained for a spin temperature in the range of 40-70 K. It is suggested that the most likely explanation for the discrepancies found for the other Orion stars is that the 21-cm emission The correlation between the OAO blended equivalent widths and color excess, 4430 Å absorption and interstellar sodium absorption are examined. Excellent correlation between sodium and hydrogen

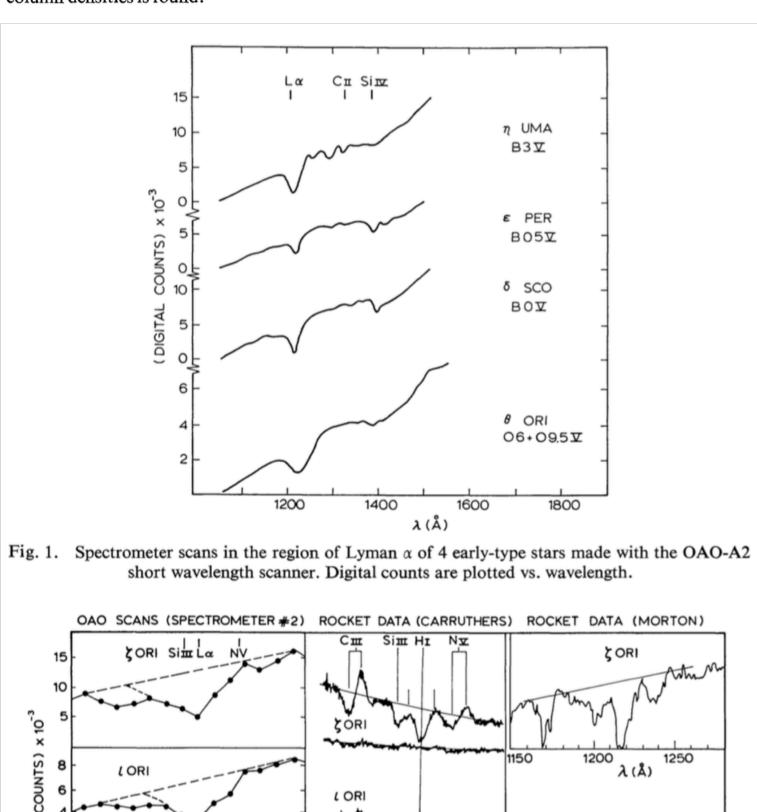


Fig. 2. A comparison of OAO-A2 scanner observations with rocket observations of Carruthers (1969) and Morton (1969). Dashed lines on OAO scans indicate adopted continuum level and portion

of Lyman α blend which is measured. For detailed information about the stars see Table I

H₂ from Sounding Rocket

1969

1970

Carruthers

MOLECULAR HYDROGEN

GEORGE R. CARRUTHERS

E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D. C. 20375 Lyman α imagery of the hydrogen geocorona was obtained from the lunar surface during the Apollo 16 mission. The images are of 20° diameter fields, with 2 arc min limiting resolution, centered on the earth and about 12° upsun of the earth. The data confirm that the hydrogen geocorona is detectable above the interplanetary Lyman α background to more than 15 R_E in the upsun direction. In the antisolar direction there is a pronounced 'geotail' effect due to solar Lyman α radiation pressure, which is markedly asymmetric about the sun line. Comparison of the data with theoretical models shows quite good agreement, particularly in the vicinity of $3 R_E$. In agreement with other observations the hydrogen density is lower than the theoretical density in the far-upsun direction, and very close to the earth there is a buildup of hydrogen on the dark side.

GEORGE R. CARRUTHERS, THORNTON PAGE, AND ROBERT R. MEIER

1971

Apollo 16

Carruthers

Apr. 1972

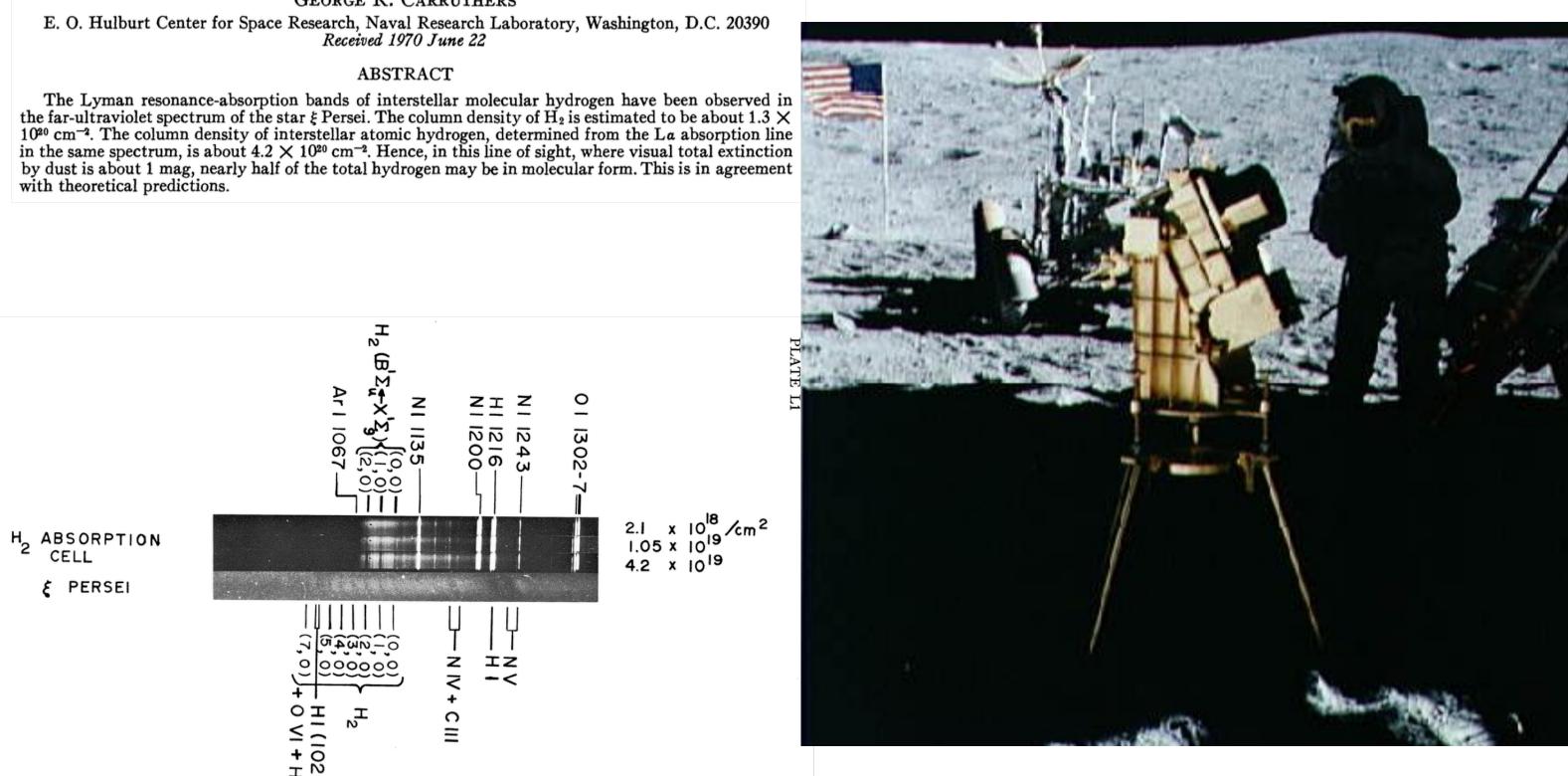


Fig. 1.—Comparison of laboratory spectra, made with a hydrogen-filled absorption cell and argon-continuum light source, with flight spec-CARRUTHERS (see page L81)

ABSORPTION CELL

Fig. 1. Print from S-201 frame 40, a 1-min exposure centered on the earth, wavelength range 1050-1600 Å. The hydrogen geocoronal Lyman α emission is the dominant feature. The dark limb is seen silhouetted against the interplanetary Lyman α background. The diagonal streaks in the upper portion of the picture are instrumental.

Copernicus (OAO-3) Apollo 17 Princeton, Spitzer-PI Spectrometer Aug. 1972

Apollo 16 Lyman Alpha Imagery of the Hydrogen Geocorona

1973

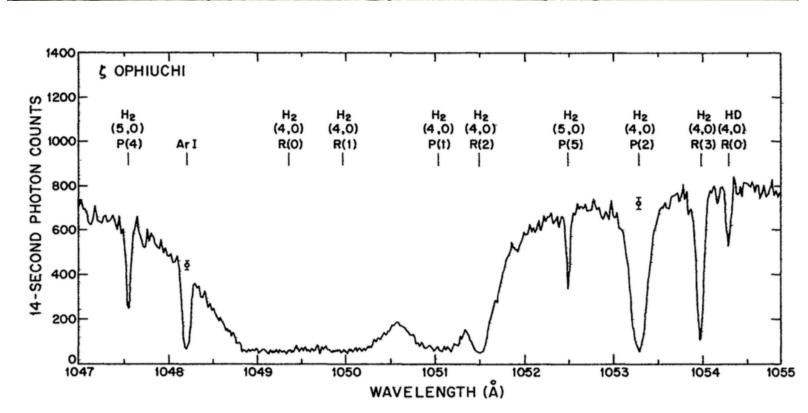
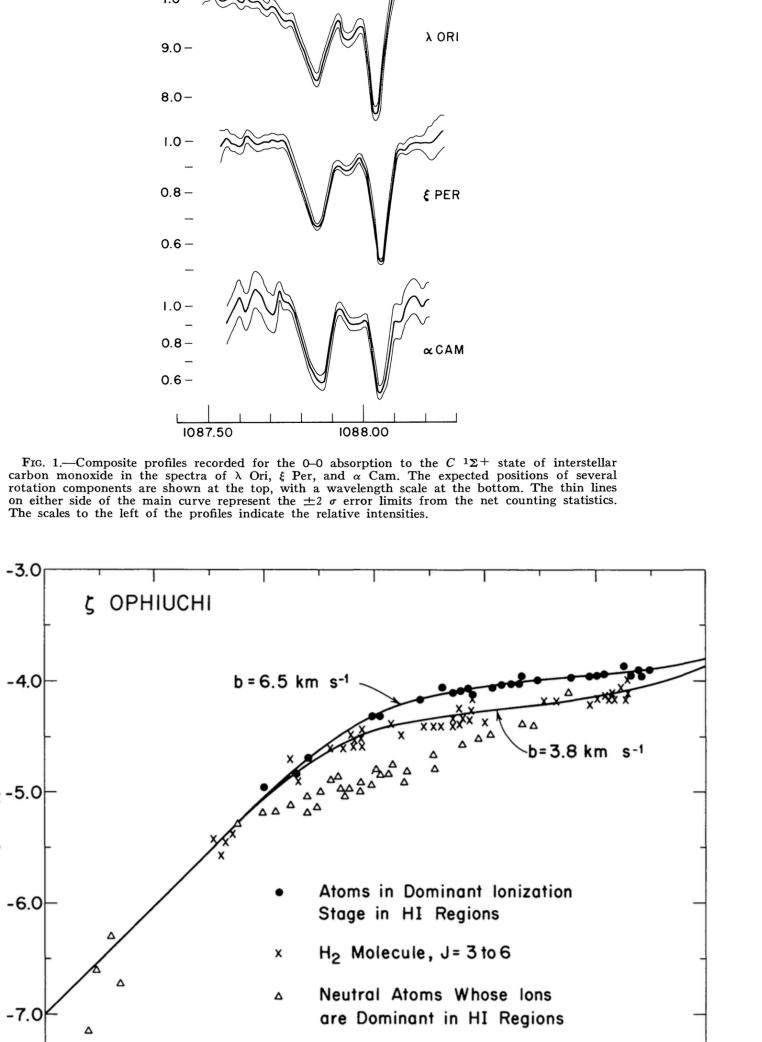


Figure 1 High-resolution scan of the O9.5 V star ζ Oph $[m_V = 2.56, E(B-V) = 0.32]$ over an 8-A interval. Error bars show the dispersion in photon counts expected from statistical fluctuations. The wavelengths of an Ar I line and of various rotational features in the (4,0) and (5,0) vibrational Lyman bands of H₂ and HD are shown by vertical lines.

RESULTS FROM COPERNICUS

CO $C_1\Sigma_+ \leftarrow X_1\Sigma_+$

L125



log Nfλ (cm⁻¹ Figure 2 Curves of growth for different groups of interstellar lines in ζ Oph. The filled circles represent lines produced by N I, Ar I, Mg II, Si II, S II, and Fe II; the triangles show C I, Na I, Mg I, S I, K I, and Fe I. The crosses represent H₂ Lyman lines from the rotational levels J = 3-6.

Dec. 1972

1975



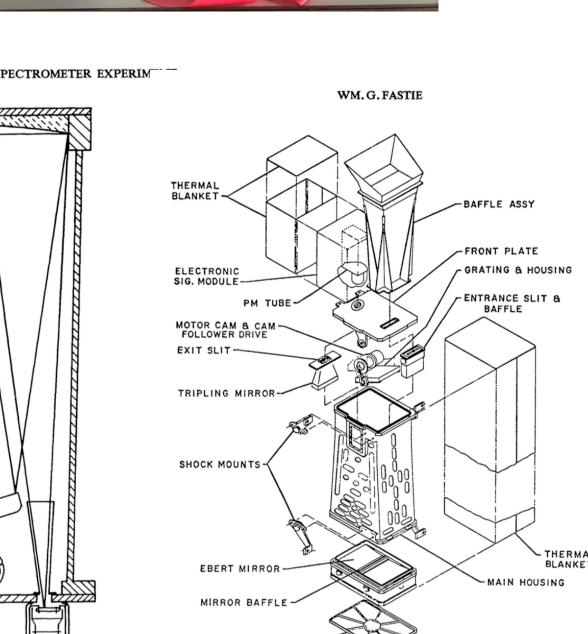


Fig. 2. Exploded isometric view of spectrometer.

Davidsen, Hartig, Fastie 3C273, Sounding Rocket JHU, Fastie-PI (21.054UG) Sept. 1977

1977

"Suddenly we were no longer astronomers, we were

Astrophysicists!" – William Fastie

Nature Vol. 269 15 September 1977

articles

1976

Ultraviolet spectrum of quasi-stellar object 3C273

Arthur F. Davidsen, George F. Hartig & William G. Fastie Department of Physics, The Johns Hopkins University, Baltimore, Maryland 21218

The first direct observation of the ultraviolet spectrum of a quasi-stellar object (QSO) has been made with a rocketborne telescope. The emission line spectrum of 3C273 similar to the spectra of high-redshift QSOs, but no absorption is observed. The results provide important new constraints on theoretical models of QSOs, place a severe limit on the density of neutral hydrogen in the intergalactic medium, and suggest a cosmological origin for much of the absorption seen in high-redshift QSOs. Comparision of the ultraviolet spectrophotometry of low- and high-redshift

QSOs suggests that the universe is closed, with $q_0 \sim 1$.

off before flight. The spectrum observed in the target channel is displayed on the ground in real time by a multichannel analyser. The overall effective collecting area of the FOT varies between 11 and 5 cm² over the range 1,250-1,700 Å. Pre-flight and post-flight calibrations agree within the errors of less than 5%. The absolute calibration, obtained by comparison with neasurements made with an NBS-calibrated photodiode, is accurate to about 10%. The instrumental resolution is about 10Å over most of the spectrum and degrades to about 15Å at A unique rocket pointing system has been developed for the

FOT by the Sounding Rocket Division of NASA's Goddard Space Flight Center. Two star-trackers are mounted behind the telescope primary, with adjustable mirrors which enable

The New Hork Times State of the State of the

Fastie Names Hubble 1976

THE JOHNS HOPKINS UNIVERSITY DEPARTMENT OF PHYSICS HOMEWOOD CAMPUS BALTIMORE, MARYLAND 21218 February 23, 1976

Fig. 1. Plan view of spectrometer optical system

Dr. James C. Fletcher, Administrator National Aeronautics and Space Administration Code A Washington, D. C. 20546 Dear Dr. Fletcher You have previously received the enclosed copies of Dr. Muller's correspondence with Senator Mathias urging that the Congress provide proper funding for the Large Space Telescope Dr. Muller's point about the international contributions of American "know-how" in astronomical instrumentation is a significant one. The truly spectacular technological accomplishment that this observatory will represent - undoubtedly the most advanced,

most complex and most perfect device that mankind has ever con-

ceived - will stand for many decades as a beacon which will demon-

the bicentennial year would be an excellent time to formally initiate

strate our greatness and our character to the whole world. Therefore,

the construction of the facility. Wouldn't it make sense to name the observatory for a famous American astronomer to further emphasize our prestigious position? The "Hubble Astronomical Observatory" would be appropriate because more than any American astronomer his name is internationally known and the large telescope will be particularly suited to extending Hubble's contributions.

Adjunct Research Professor The Hon. J. L. McClellan cc: The Hon. J. Glenn Beall, Maryland The Hon. G. H. Mahon Maryland Congressional Delegation Members of LST Working Group: The Hon. William Proxmire, Wisconsin J. N. Bahcall The Hon. Edward P. Boland, Massachusetts E. M. Burbidge A. D. Code The Hon. Olin Teague, Texas G. B. Field The Hon. Don Fuqua, Florida L. Spitzer, Jr. Dr. Nancy Roman, NASA Hdqts.

Rest wavelength (Å) 1,200 1,300 Fig. 1 The ultraviolet spectrum of the QSO 3C273. The strongest emission line is hydrogen Lyman α λ 1,216 with a redshift z =0.16. The asymmetry of the line is attributed to N(v) $\lambda 1,240$ mission. The broad feature at λ_{rest} 1,400 Å is similar to that usually attributed to Si (IV) and O (IV) in high-redshift QSOs.

There are also probable emission features which may be due to O (I) λ1,304 and Si (II) λ1,265. The continuum is flat, with no evidence of strong absorption shortward of Lyman α.

Idea of Ever-Expanding Universe Dealt a Blow by Two New Studies

After several years in which various; For example, if at night one tried to observations seemed to indicate that the estimate distances to many houses by the universe is infinite and destined to ex-|brightness of lights in their windows, it pand forever, two studies have revived would help to known that the brightest the possibility that it is finite and predes- light visible in each was a "standard can-The new observations, looking at the In a search for such "100-watt bulbs" problem in separate but related ways, Dr. Allan R. Sandage of the Hale Observasuggest that expansion has already tories in California has for a number of slowed enough to end in a falling back years used the brightest elliptical galaxy together of all the galaxies and stars bil- in each cluster of galaxies. It has been One study used quasars and the other Kristian and William Westfall, with Dr. used brilliant, distant galaxies as "stand- Sandage, that suggests enough slowing ard candles" to see if the expansion rate of the universe's expansion to imply was considerably greater long ago. In eventual collapse both tests, this appeared to have been | Last night, however, Dr. Sandage, in the case. But in each case the findings a telephone interview, pointed out that The term "standard candle" is applied necessary and that the earlier arguments to astronomical objects believed to be for an open, infinite universe also continof uniform intrinsic brightness. This ue to be persuasive. makes it possible to estimate an object's The quasars had seemed hopeless as relative distance by the dimming of its light in its journey to an observatory. | Continued on Page A13, Column 1

Copyright © The New York Times

VOL CXXVII ... No. 41,386 NEW YORK, THURSDAY, SEPTEMBER 22, 1977 20 CENTS LANCE RESIGNS, 'CONSCIENCE CLEAR'; CARTER DEFENDS HONOR OF 'MY FRIEND' Aides Report Carey Will Support | DEFICIT IN NEW YORK | Kech and Scrap Pledge to Cuomo | PUT AT \$350 MILLION | Condesed as Page 84, Column 1 srael Would Grant ATOM SALES CONTROLS Naval Base to U.S., House Panel Is Told ty recovers emercency (Landan Meeting Agrees on Folia) Could Always Work Things Out

"In both tests, the observed brightness and therefore into the past.

caused by expansion of the universe. This far away that their light has taken bil- gen known as Lyman alpha, relative to was expressed by the mathematical term. Those who have become convinced exmotion is manifest in a shift of spectral lions of years to reach the earth. They the background light of the quasars. q zero. If it exceeds 0.5 the universe is pansion of the universe will never end TO UNVERSE THEORY

The spectrum.

Red lies are fine extreme of the visible spectrum.

Red lies are fine extreme of the visible strength of the opposite, or short-wave end. The spectrum in the long-wave end, and their dimers in light from the affect that those with certain spectral features in shift" increases systematically at those with certain spectral features that those with certain spectral features the been informly bright and enabled a group at the Johns Hopkins group on the spectrum for the spectrum in the background light of the quasars are so far away that ultraviolet universe is the background light of the quasars are so far away that ultraviolet wave therewise in lines in light from the affect that the same test to aclosed. The admittedly tentative indicates the profit of views, mexical they have been shifted to the visible part of the spectrum.

At such great distances, as estimated the phase there is a closed quasar whose universe the strength of the treatment of the past.

At such great distances, as estimated the phase there is the pitch of a receding horn.

In a uniformly expanding universe this is plotted graphically against that those with certain spectral features of galaxies, they tend to lie along a group at the Johns Hopkins group of galaxies, they tend to lie along a treatment of the past.

The background light of the quasars are so far away that ultraviolet universe is the background light of the quasars are so far away that ultraviolet universities in light from the adjust quasars are so far away that ultraviolet universities in light from the appearance of the visible part of the spectrum.

The Hale Observations of 139 galaxies, some preduct they have been shifted to the visible part of the spectrum. To see the slowing they have been shifted to the visible part of the spectrum. To see the slowing was 16, with they have been shifted to the visible part of the spectrum. They more opporate that the ministration of the quasars are so far away that ultraviolet universible them that the min "In both tests, the observed brightness and therefore into the past.

Hopkins group concerned the brightness quasars, determined by the spectral method Davidsen, George F. Hartig and William cosmologists should always state These of each object has been compared with The most distant galaxies and seem of quasar emissions at certain ultraviolet od, the result "favored" a slowing rate Fastie reported their findings in the Sept. are the opinions upon which I shall base its observed motion away from the earth, ingly even more distant quasars lie so wave lengths, such as those from hydro-that would end in collapse. The slowdown 15 issue of the British journal Nature.

my facts."