

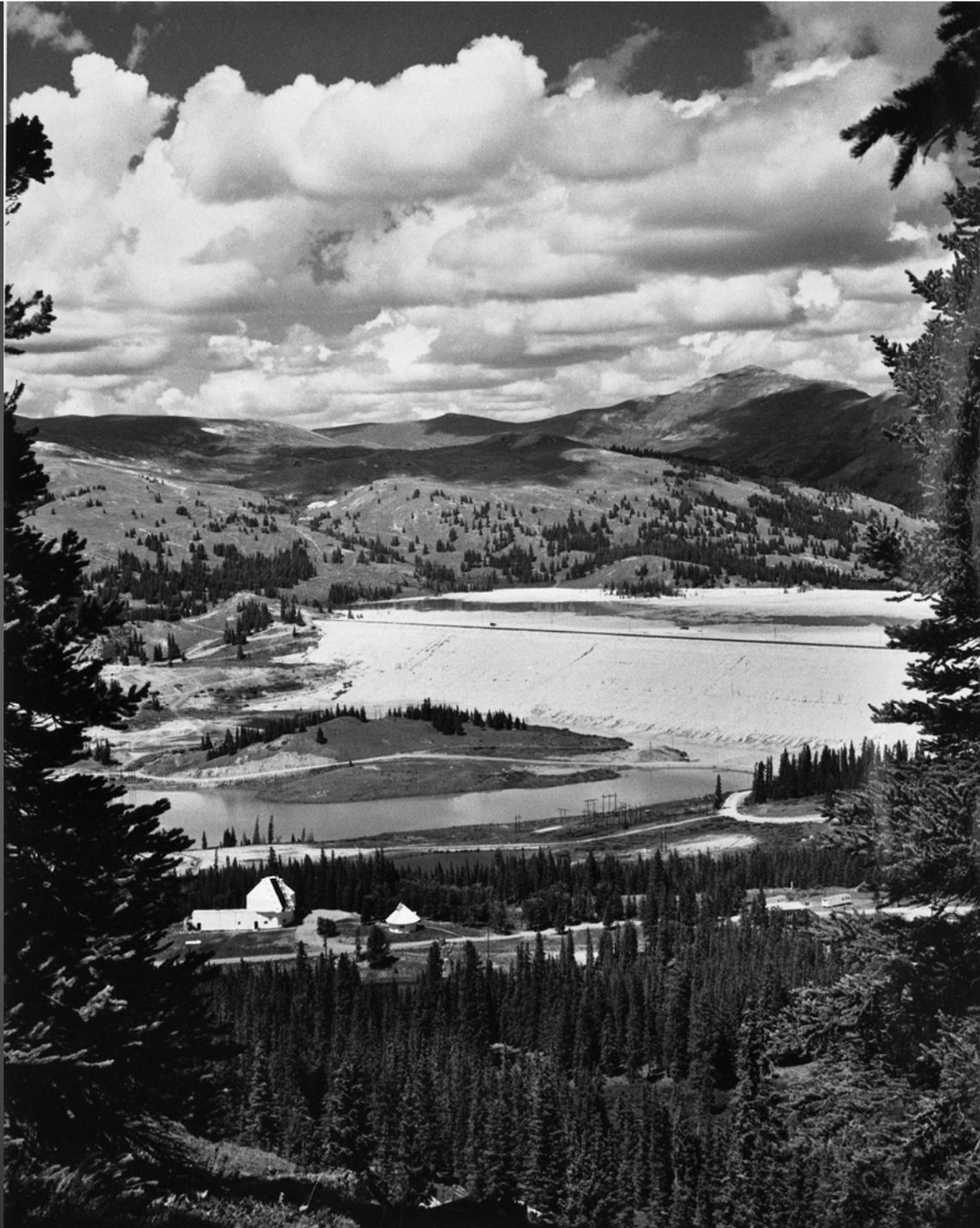
In the Wake of the Fairwind. . .

A personal view

Dick Fisher
24 October 2010

Winter 1964

- January 7 – February 29 The 1964 Winter Olympics are held in Innsbruck, Austria
- January 17 John Glenn, the first American to orbit the earth, resigns from the space program.
- March 14 - A Dallas, Texas jury finds Jack Ruby guilty of killing John F. Kennedy's assassin Lee Harvey Oswald.
- April 4 - The Beatles hold the top 5 positions in the Billboard Top 40 singles in America, an unprecedented achievement. The top songs in America as listed on April 4, in order, are:
 - Can't Buy Me Love, Twist and Shout, She Loves You, I Want to Hold Your Hand, and Please Please Me.
- May 2 Some 400-1,000 students march through Times Square, New York in the first major student demonstration against the Vietnam War.
- Nobel Prize in Physics: Charles Hard Townes







Themes

- Seeing the Unseen - Journey to the IR.
- Curiosity -do the continents fit together?
 - Before – how did humans perceive nature?
 - The Sea, the Sky and the Stars
- The Pacific – scientific exploration
 - Cook

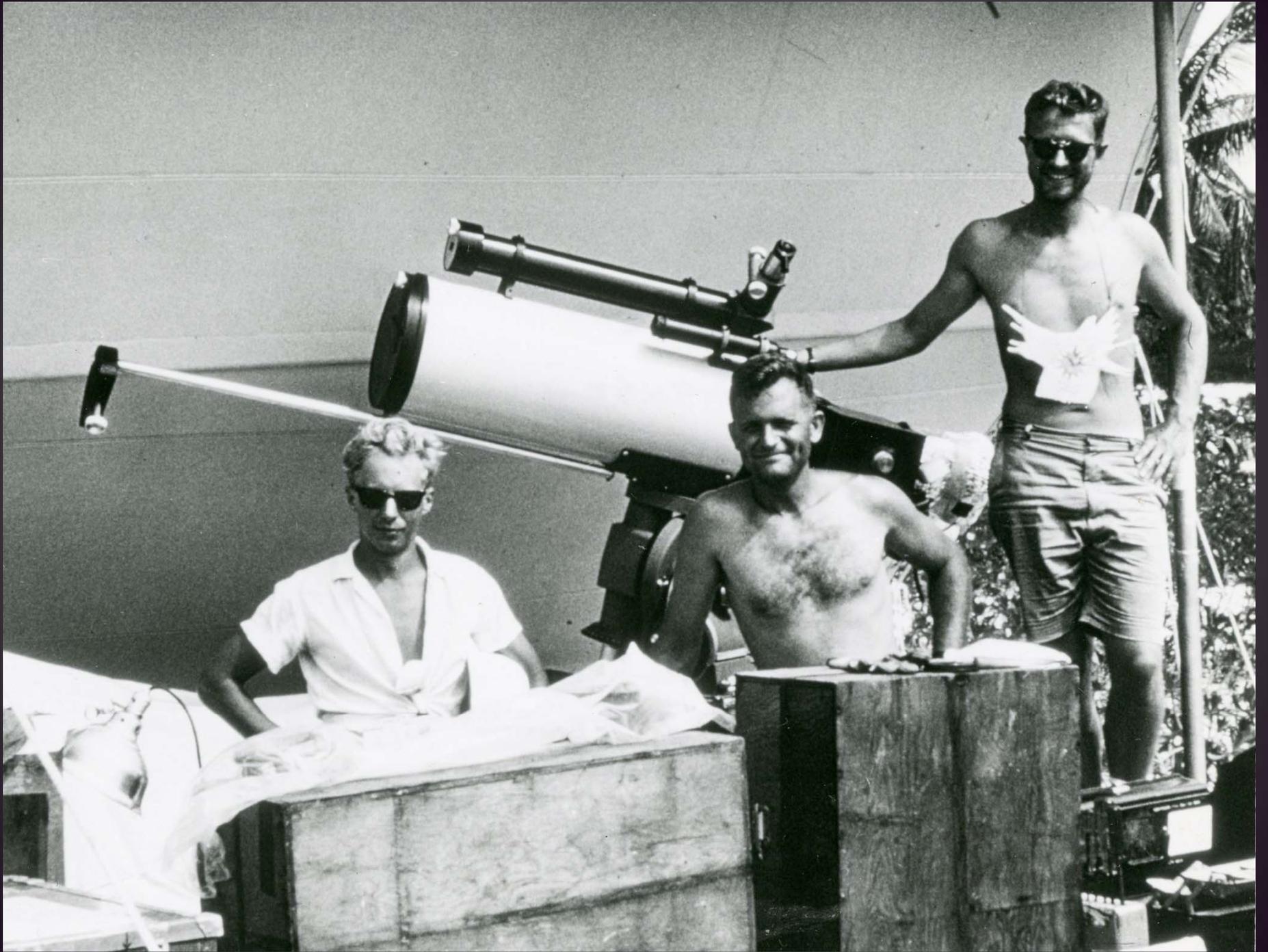
- What – is happening and what's going to happen next – the IGY
 - To the Sun . . .
 - At the Earth . . .
 - .

1965



342 miles wnw of Raiatea, west of the Tuamoto archipelago and east of French Polynesia, lies Bellingshausen Island . . .





OBSERVATIONS OF THE EMISSION LINES OF Fe XIII DURING
THE SOLAR ECLIPSE OF MAY 30, 1965

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Received February 27, 1967; revised April 10, 1967

ABSTRACT

Photoelectric measurements made during the eclipse of May 30, 1965, show linear polarization of $\lambda 10747$ ranging between 8 and 30 per cent. Observations were made at four positions in the corona between 1.2 and 1.72 solar radii. The electric vector of $\lambda 10747$ is found to be approximately radial. From the observed line to continuum ratios the estimated abundance of iron relative to hydrogen is approximately 8×10^{-4} .

I. INTRODUCTION

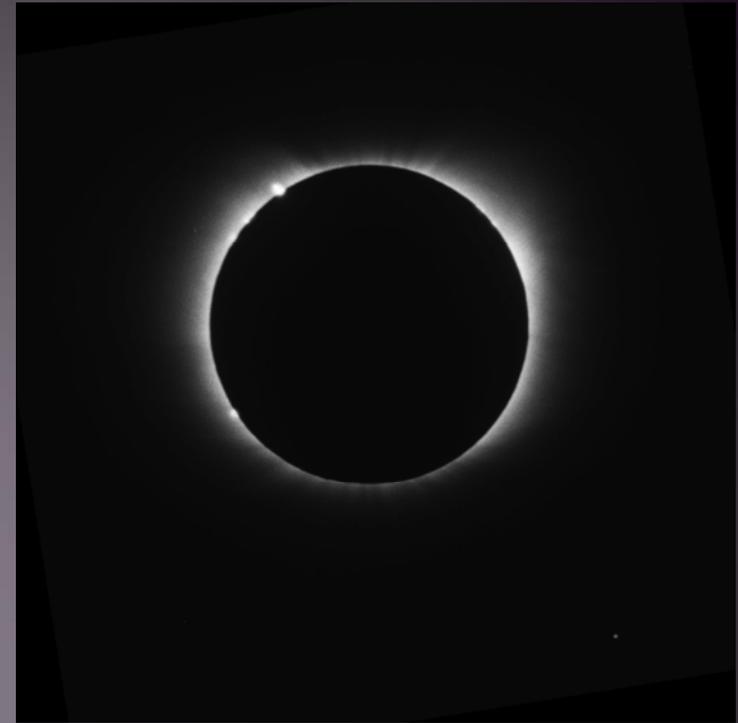
Although the two infrared lines of Fe XIII have the largest line to continuum ratios in the visible and infrared coronal spectrum, they have been studied little compared to the extensive observational work on the green and red coronal lines. The problem is observational: the lines lie beyond the effective range of photographic emulsions and at the low efficiency tail of the S-1 photocathode. A review of observations of the infrared pair has been given by Malville (1967). The two infrared lines plus the slightly weaker lines [Fe XIII] $\lambda 3388$ provide an effective but rarely used means of investigating the detailed properties of the corona.

The stronger of the infrared pair, $\lambda 10747$ ($^3P_1-^3P_0$), is of particular interest. Since its lower level has but one magnetic quantum state, it will exhibit complete resonance polarization when radiatively excited and will attain a degree of linear polarization approaching that of the K corona (Hyder 1965). The degree of linear polarization will, however, be less than that set by the limits of radiation anisotropy due to the precession of the ion in a coronal magnetic field. Line-of-sight integration and collisional excitation will reduce the observed polarization still further. The direction of polarization of $\lambda 10747$ should differ by 90° from that of the electron scattering continuum; the electric vector of $\lambda 10747$ should be approximately radial with respect to the Sun. Such an orientation arises from resonance scattering of magnetic dipole radiation.

Since resonance polarization will generally be largest when radiative excitation dominates, measurements of emission-line polarization can help to locate regions of radiative excitation in the corona in which the interpretation of line intensities is relatively straightforward. In these regions the determination of coronal abundances is no longer influenced by the uncertainties of collision cross-sections and density fluctuations along the line of sight. Observations of line intensities and polarizations at large distances above the limb thus become the most reliable and direct means of determining ion abundances in the corona. One may also use line polarization measurements to deduce some parameters of the coronal magnetic field.

Polarization of the coronal green line, though less than that predicted for $\lambda 10747$ has been found by a number of observers (Karimov 1961; Charvin 1965; Mogilevsky, Nikolskii, and Nikolskaya 1961; Hyder 1966). Hyder (1966) has verified that the direction of the electric vector of $\lambda 5303$ is radial. To our knowledge the work reported here represents the first observations of polarization in $\lambda 10747$. Perche (1965*a, b*) has made a detailed theoretical study of the polarization of the Fe XIII lines.

* Alfred P. Sloan Research Fellow.



“To our knowledge the work reported here represents the first observations of polarization in $\lambda 10747$.□

Winter of 1973-1974



1974A&A...34..235E

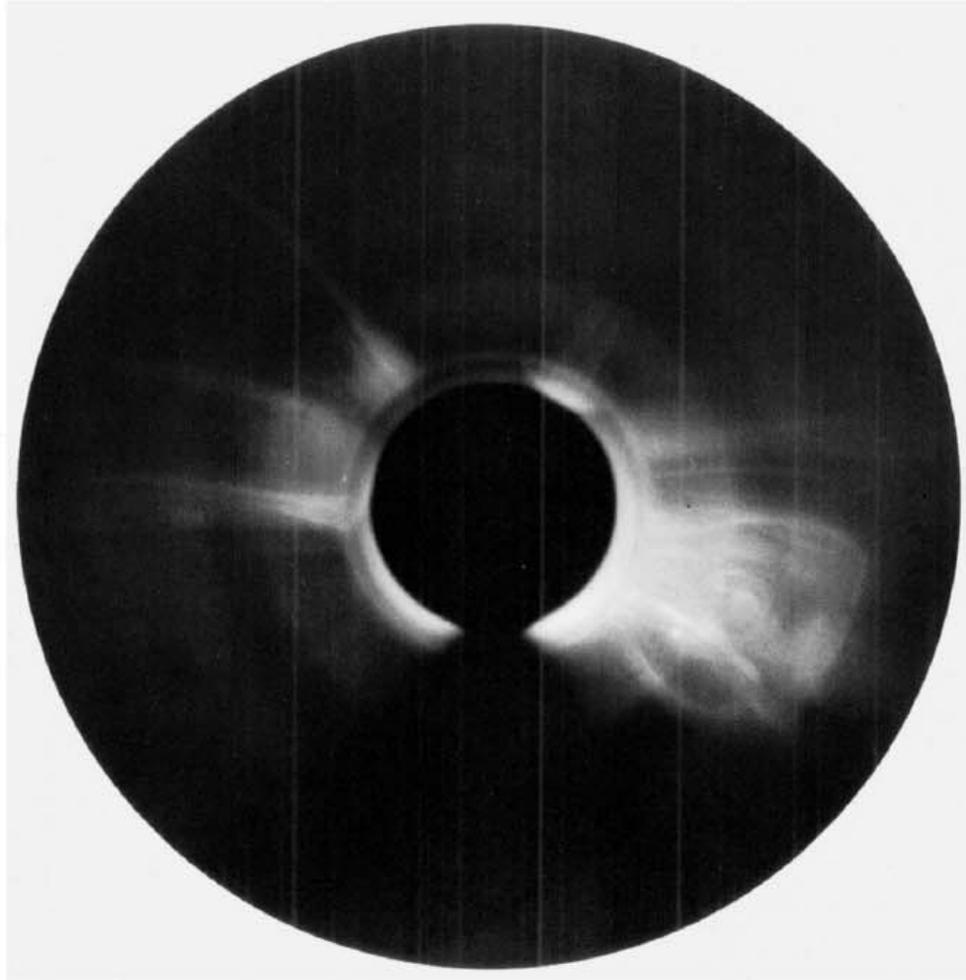


Fig. 1. Coronal photograph taken 0954 UT 10 June 1973 (11 min after Fig. 2 of MacQueen *et al.*, 1974) by HAO White Light Coronagraph Experiment on first NASA Skylab mission. Diameter of occulting disk is about $1.5 R_{\odot}$. Transient feature at lower right (in northeast quadrant) was observed for about 30 min and moved outward with an apparent velocity of 450 km/s

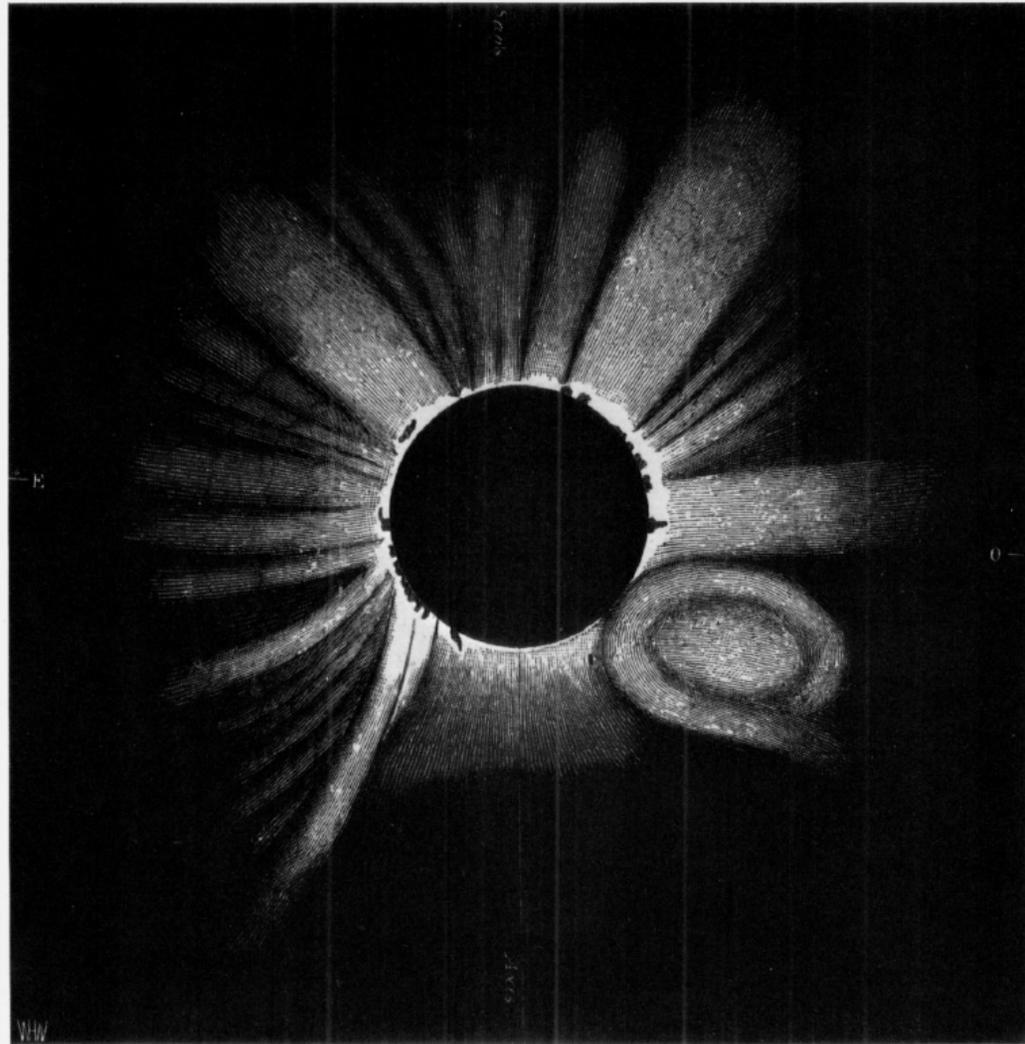
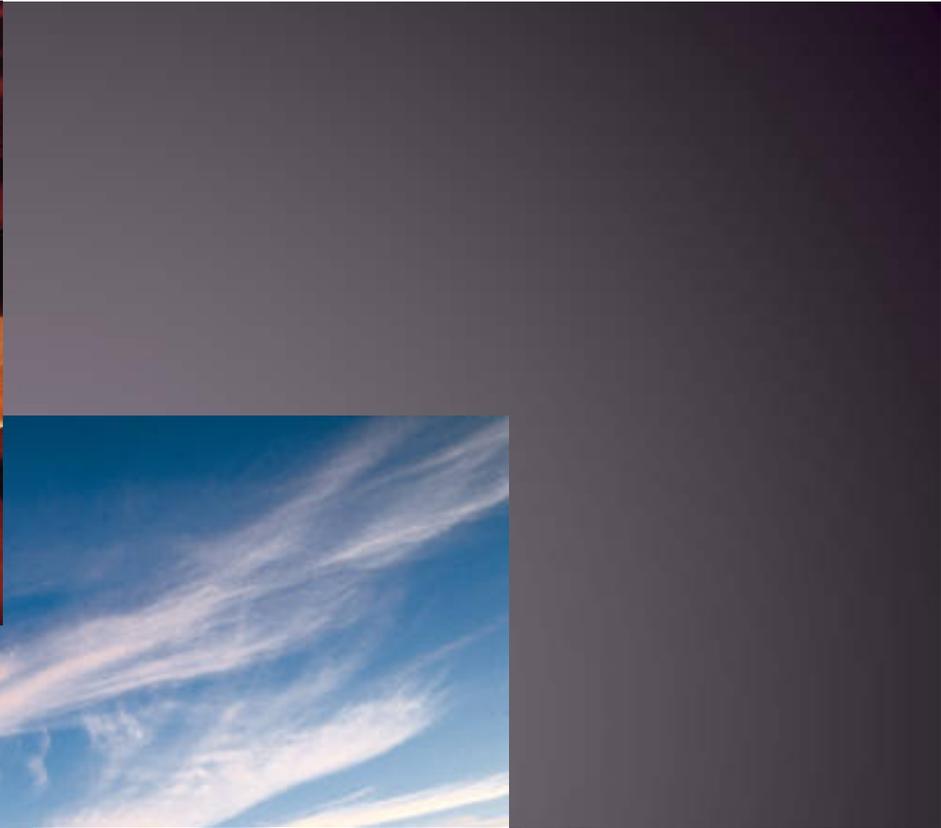


Fig. 2. Drawing of the corona as it appeared to Tempel at Torreblanca, Spain during the total solar eclipse of 18 July 1860 (Ranyard, 1879).
South is at bottom, west at right

Some Themes

- Seeing the Unseen - Journey to above the atmosphere.
- Curiosity
 - Before – how have humans perceived CMEs in nature?
 - Why did prehistoric north Americans pile rocks on high places?
 - Who was first to see a sunspot?
Who first knew there was a magnetic variability cycle in the Sun?
 - How do systems of systems fit together?
 - Are such systems predictable?
 - Climate changes?

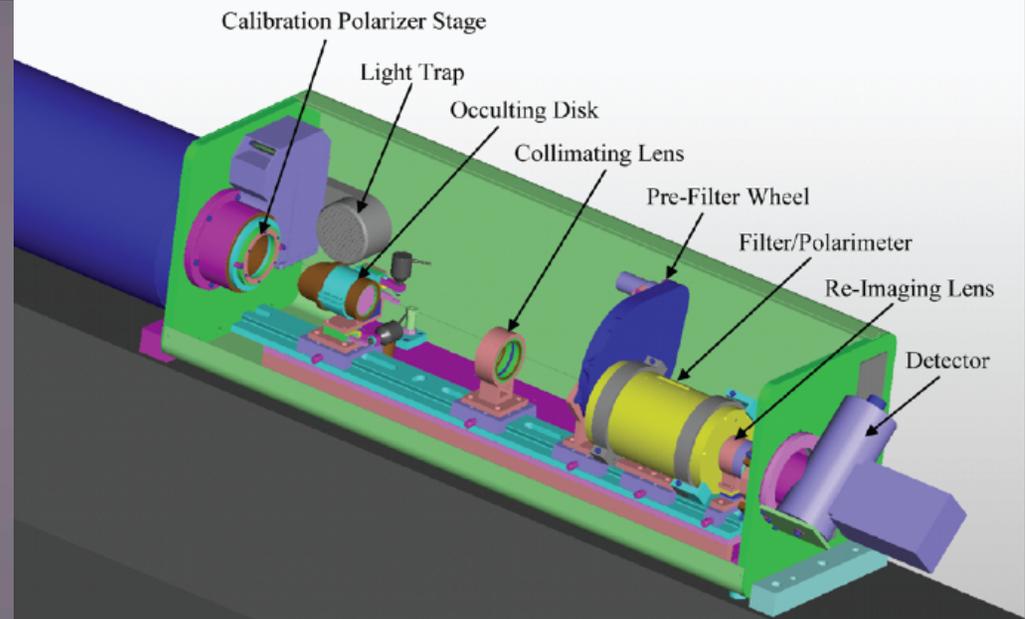
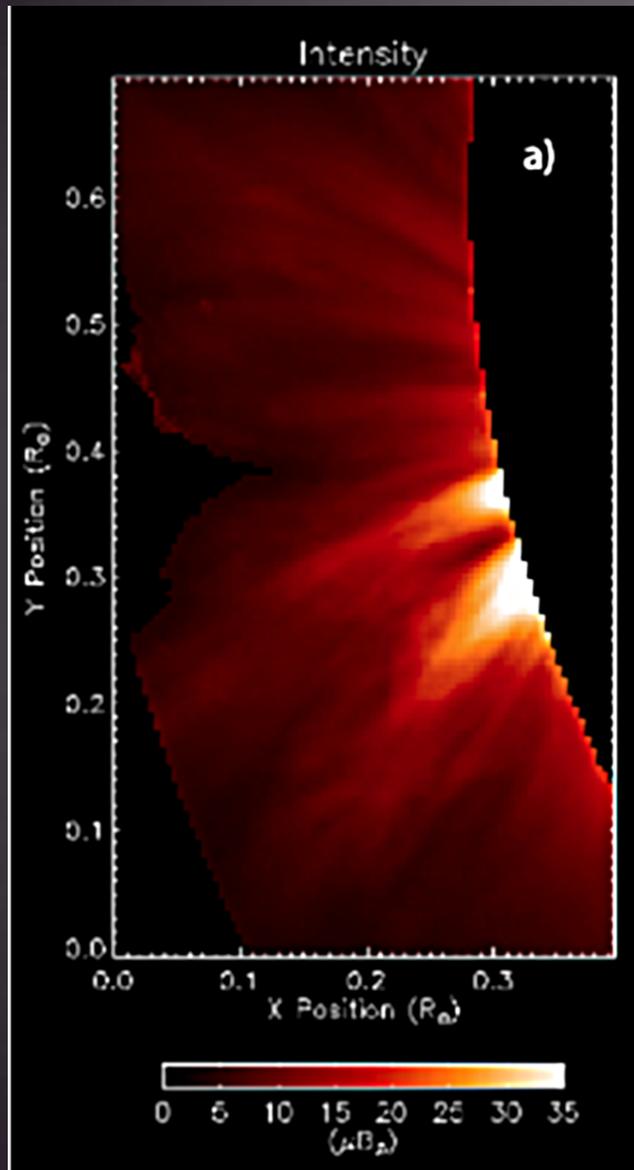


Walt's Test:

- Walt's Test:
- On one side of a single sheet from the wastenot box of paper: Sit down and in 300 wds say what you did the last year –review it in terms of the cultural , intellectual, economic and political impacts and assume that you have been successful (at least to some degree).
- Answer the questions – only two - but both required for full credit –
- So What?
- Who Cares?
- In the '80s Walt reminded me of the other two research values. . .
- In my case, the first (and only time I went through this drill, it elicited a speculation from John Firor that probably I didn't actually know what I was doing.

An Instrument to Measure Coronal Emission Line Polarization

S. Tomczyk · G.L. Card · T. Darnell · D.F. Elmore ·
R. Lull · P.G. Nelson · K.V. Streander · J. Burkepile ·
R. Casini · P.G. Judge



“We have constructed an instrument to measure the polarization of light in order to constrain the strength and orientation of coronal magnetic fields.

Advanced Technology Solar Telescope



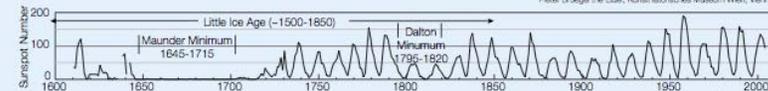
Sun and climate

We think of the Sun as constant, but physical and historical records show variations, the most famous being the sunspot number, a count of actual sunspots and sunspot groups (above). A 22-year Hale cycle — two 11-year cycles with solar magnetic poles reversing every 11 years — appears to be the norm for our Sun, based on just four centuries of data with some hiccups. For example, the Maunder Minimum, a 70-year period (1645-1715, spanning about three complete Hale cycles) without spots, coincided with severe winters and shortened summers as Europe experienced a period known as the Little Ice Age (about 1500-1850). The period was brutal enough that Henry VIII and his court were able to ride horses across the frozen Thames River in 1536, and London had Frost Fairs on the Thames as late as 1814. Pieter Bruegel's "The Hunters in the Snow," painted in 1565, is widely believed to depict severe conditions during this era. The Maunder Minimum is more than a coincidence. Although consistently accurate sunspot counts only started a few decades after the discovery of sunspots in 1612, scientific data (such as tree ring analyses and carbon-14 in organic remains) and historical records of harvests and first frosts point to sunspot lows coinciding with other cold spells, such as the Spörer Minimum (1415-1510) and Dalton Minimum (1795-1820), and sunspot highs

areas. On balance, plages and network lines outweigh sunspots, and the Sun thus appears brighter at sunspot maximum. One aspect of increased solar activity is that solar ultraviolet emissions have a greater brightness range than the Sun as a whole. As a result, ozone, an important greenhouse gas in the stratosphere, varies in direct response to daily changes in the solar ultraviolet irradiance that forms



Pieter Bruegel the Elder, Kunsthistorisches Museum Wien, Vienna



with warm spells such as the Medieval Maximum (900-1300) when Greenland was green and colonized by the Vikings, as compared to today's glacial island.

(Climate is a general description of long-term environmental conditions across regions or the entire planet. Weather refers to local short-term variations in conditions. However, climate sets the stage for types of weather.)

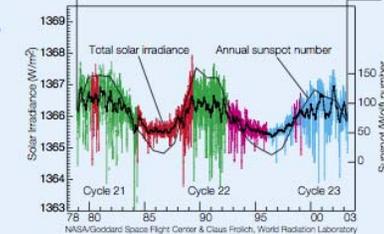
We are still uncovering the links between solar activity and terrestrial climate because neither is fully understood. Earth's climate system is highly complex, comprising large heat sinks like the oceans, that form a buffer and delay (sometimes by years or decades) a response to shifts in solar irradiance.

On the solar side of the question, we learned in the last few decades how variable the "constant" can be, and thus refer to total solar irradiance (TSI). Irradiance values averaged from satellite data (different colors in the graph indicate different satellites) show daily variations as solar active regions arise and disappear and move across the solar disk. Annual sunspot numbers for cycles 21-23 are superimposed on the graph at right to show how the two correspond.

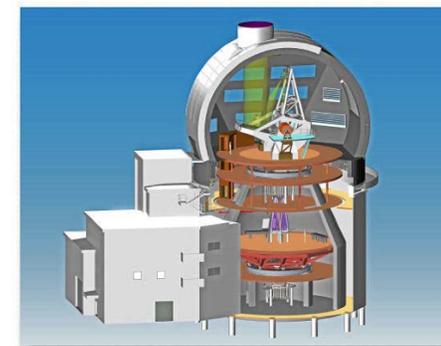
The paradox in sunspot variations is that the Sun is brighter when it has more spots. What was revealed by modern instruments (and not readily apparent to observers relying on just their eyes) is that sunspots are accompanied by brightened areas, plages (French for beach) and by bright network lines connecting magnetically active

by splitting oxygen molecules (O_2) into free atoms that recombine to form ozone (O_3). The implication is that periods like the Maunder Minimum could allow natural depletion of ozone and lead to global cooling.

Further, only recently have we established that the Sun's total energy output varies slightly with the "normal" sunspot cycle, as we understand it. Such data can only be collected by satellites above Earth's atmosphere (right) and thus exposed to the full range of solar energy. The data clearly show a variation with sunspot numbers. We also know that geomagnetic storms, driven by solar activities, provide an additional, variable energy input through the polar caps.



Science Goals of the ATST



January 2004

There are several Zeeman splitting measurements of prominence magnetic fields (Lin et al. 1998) but the coronal problem is significantly harder. Because the Zeeman splitting-to-Doppler width ratio of an emission line increases with wavelength, the magnetic sensitivity from splitting measurements increases with wavelength. The magnetic sensitivity of the IR lines is an important motivation for exploring the IR coronal spectrum (Fig. 2.24). For example, the Fe XIII line at 1.075 μm has just

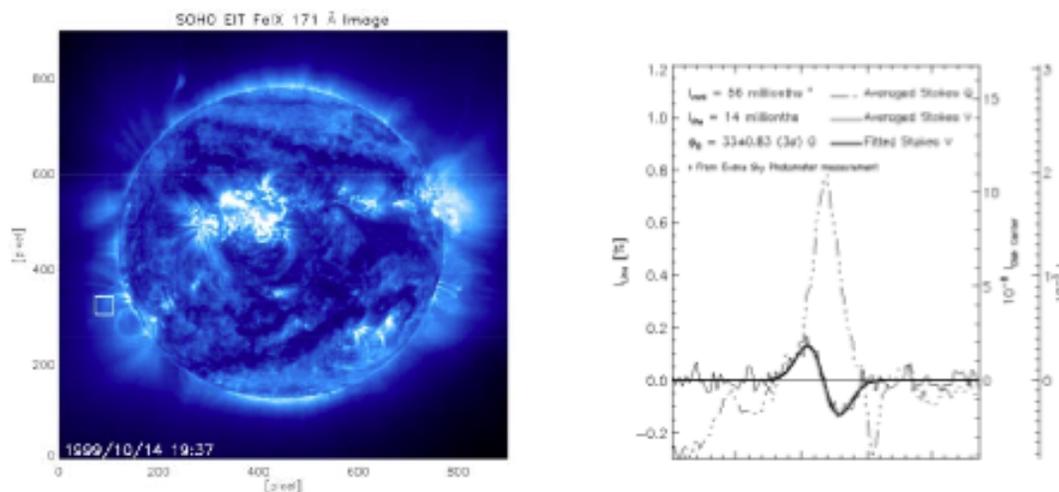


Figure 2.25. Measurement of coronal magnetic fields. The box in the SOHO/EIT FeIX 171 Å image (left) shows the region observed with the Evans Solar Facility at Sacramento Peak. Images on the right show averaged Stokes Q and V spectra measured in the 10747 Å line. In spite of the 40-minute exposure and spatial averaging, the signal-to-noise is poor. Nevertheless, the weak Stokes-V detection is obvious. The field strength derived from this averaged spectrum is 33 gauss. The ATST will provide the sensitivity to measure the coronal field with much better resolution (courtesy of H. Lin).

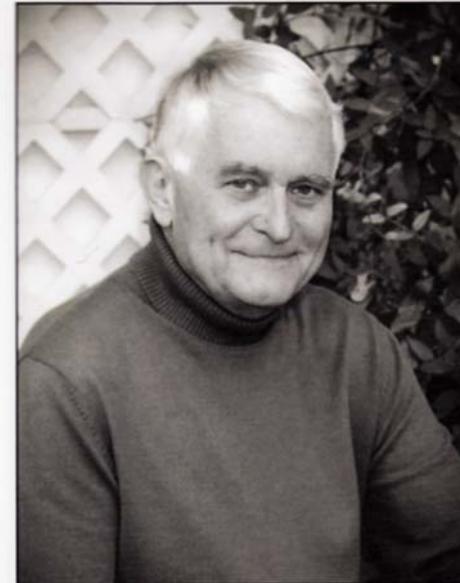
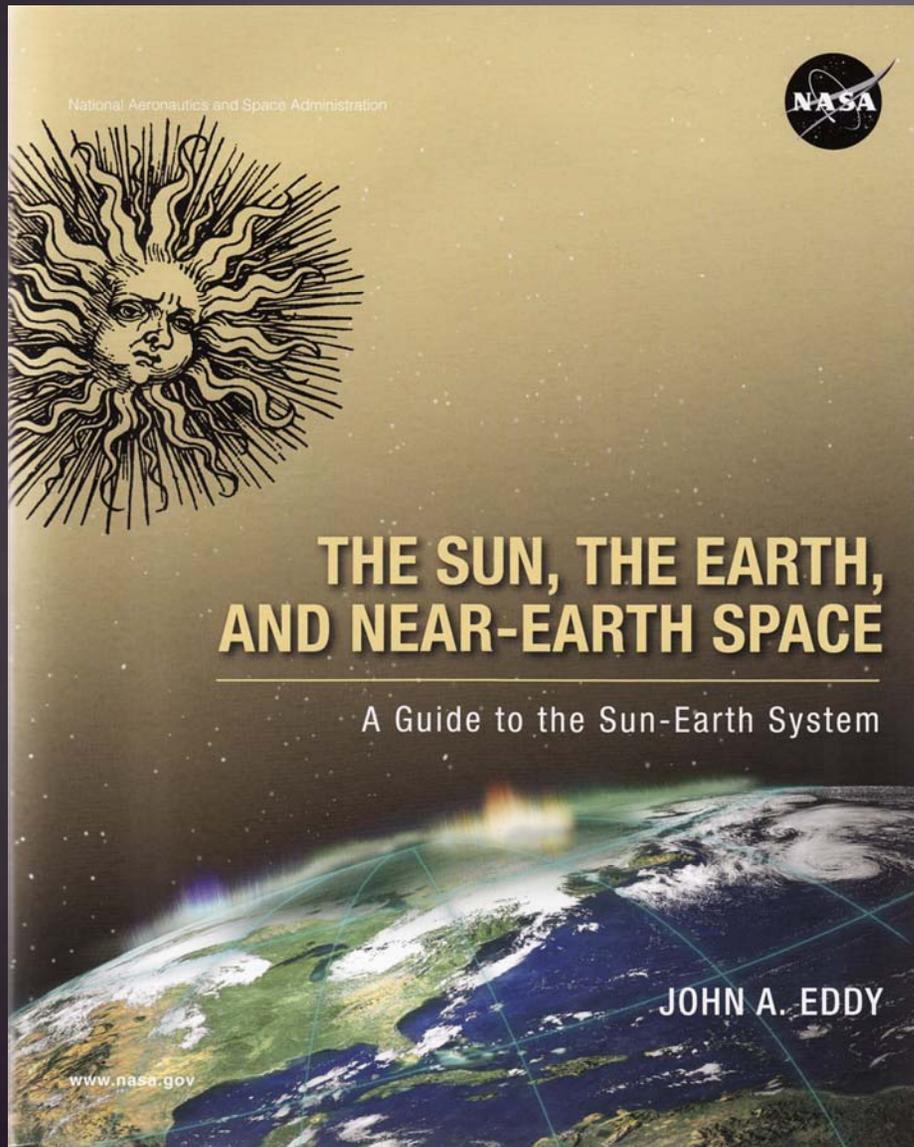
“ The ATST will provide the sensitivity to measure the coronal field with much better resolution.”

- Fearlessness - Pursuit of the path perceived ahead
- Expansion – extending sphere of human consciousness – from the local to the macro.
- Humans and the interaction within our local astronomical/planetary systems

Master Story Teller



A Primer for Heliophyscs



JOHN A. EDDY

Dr. John A. Eddy is a graduate of the U.S. Naval Academy and the University of Colorado who is best known for his work in recovering the history of the Sun and establishing the reality and nature of extended periods of anomalous solar behavior in the distant past, such as the Maunder Minimum of 1645 to 1715. He is known as well for his investigations of the astronomy of early Indians of the American plains; as a scientific editor and popular interpreter of science; and for many years, in promoting the interdisciplinary study of global environmental change. He is a fellow of the American Association for the Advancement of Science and a recipient of the Arctowski Prize of the National Academy of Sciences for pioneering work in solar-terrestrial physics.

Rendering of proposed ATST facility at the primary Mees site on Haleakalā, Maui, Hawaii by Tom Kekona, K. C. Environmental, Inc. Original aerial photo by Frank Rizzo.



Rendering of proposed ATST facility at the primary Mees site on Haleakalā, Maui, Hawaii by Tom Kekona, K. C. Environmental, Inc. Original aerial photo by Frank Rizzo.



Reviewing a number of themes

- The sea as a metaphor for exploration
- The value of the skill of thinking across academic disciplines
- The corona and its various meanings
- The sun and its variability
- Its effect on the Earth and society
- What happened before?
- What's gonna happen next ?



In his own words . . .

- <http://www.aip.org/history/ohilist/22910.htm>
|



The screenshot shows the header and navigation bar of the Niels Bohr Library & Archives website. The header features a circular portrait of Niels Bohr on the left, followed by the text "Niels Bohr Library & Archives" and "with the Center for History of Physics" in a smaller font. Below the header is a navigation bar with links: "History Home", "Book Catalog", "International Catalog of Sources", "Visual Archives", and "Contact Us". The main content area below the navigation bar has a "Library Home" link on the left and the title "Oral History Transcript — John A. Eddy" on the right.

 Niels Bohr Library & Archives
with the Center for History of Physics

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[Library Home](#) **Oral History Transcript — John A. Eddy**

I imagined Jack as standing in a relaxed frame, leaning against the rail of some vessel like the Fairwind, moving to the west west across the endless pacific. In my imagination it is near dusk, with the sun illuminating the convection cu in the sky near the horizon. The boat makes a copious wake
It's a dreamy time.

Soon the sun will set, and one senses that stars are about to appear.

It would be a time for speculating. . . about the nature of the corona and had any one ever seen and recorded strange activity at the times of eclipses, and how could we know. . .

Or perhaps the reasons that prehistoric native North Americans might have had for placing rock structures on promontories, and how could we know. . .

Is it a coincidence that the spot cycle and Jupiter's Synodic period are 11 and 12 years

Or perhaps wondering if there were important changes in the Sun and Earth in over the range of time, and how could we know. . .

Or perhaps wonder how to illustrate, with a kind, but probing irony, any number of human foibles, with a wry cartoon drawn with a characteristic draftsmanship . . .

The possibilities are unlimited. He was always so imaginative, and could think of things over ranges of time and space in ways totally unavailable to me. . .

In my daydream Night begins to fall, and the ship forges endlessly into a seamless blend of sea and stars.

Those left behind work on in his glowing wake.