A long time ago in a galaxy far, far away....

The 1962 Parkes lunar occultation observations that led to the discovery of the first quasar 3C273

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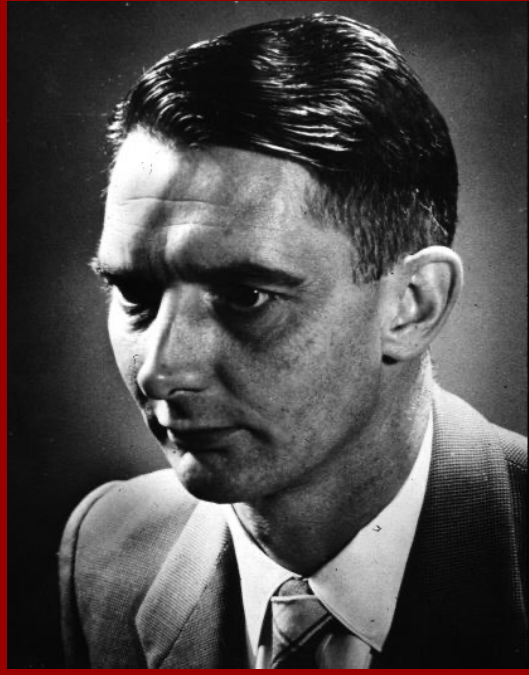
4: National Radio Astronomy Observatory
5: International Occultation Timing Association

We would also like to thank Maarten Schmidt for our many valuable discussions

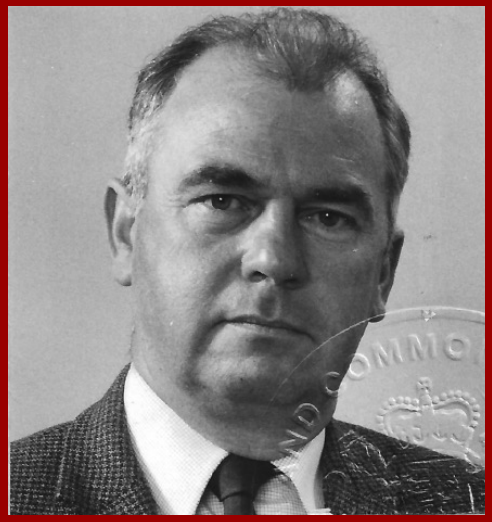
Cyril Hazard

Maarten Schmidt

3C273 the cast



John Bolton

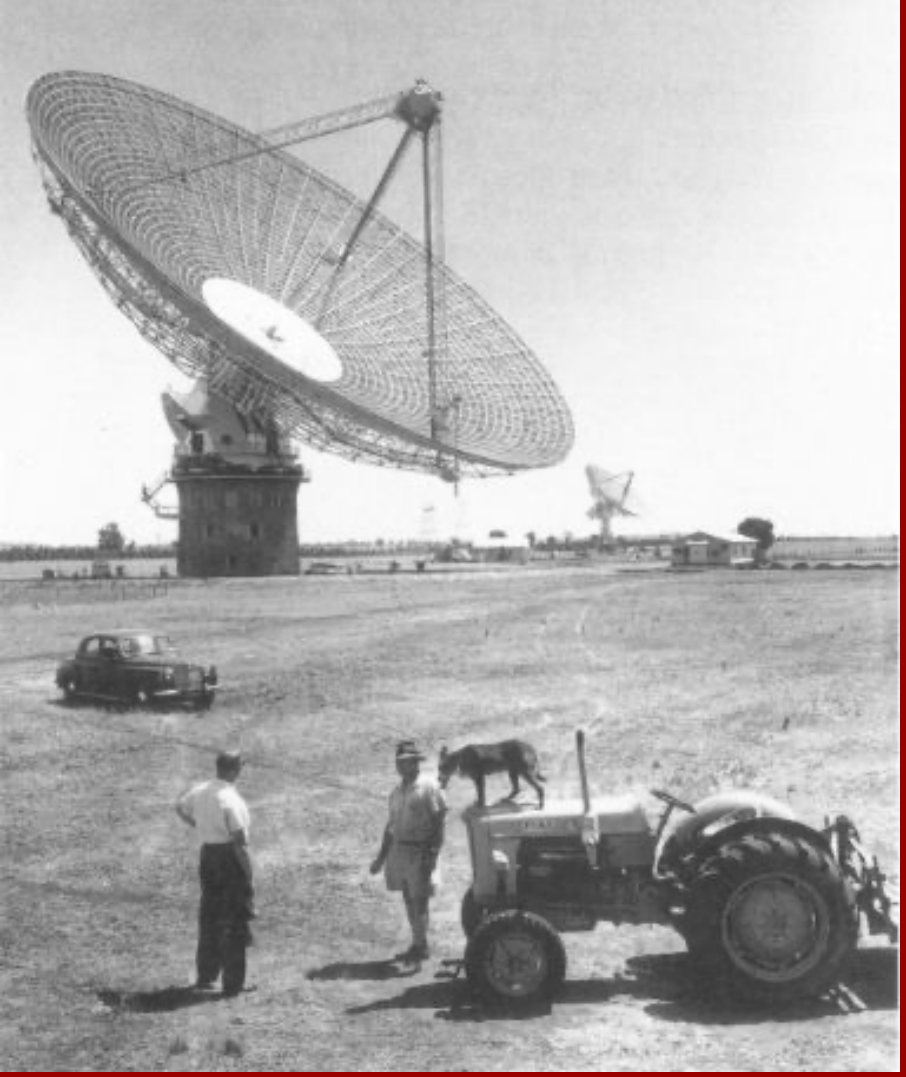


W. Nicholson

Rudolph Minkowski

Joe Pawsey

the telescopes
need no introduction



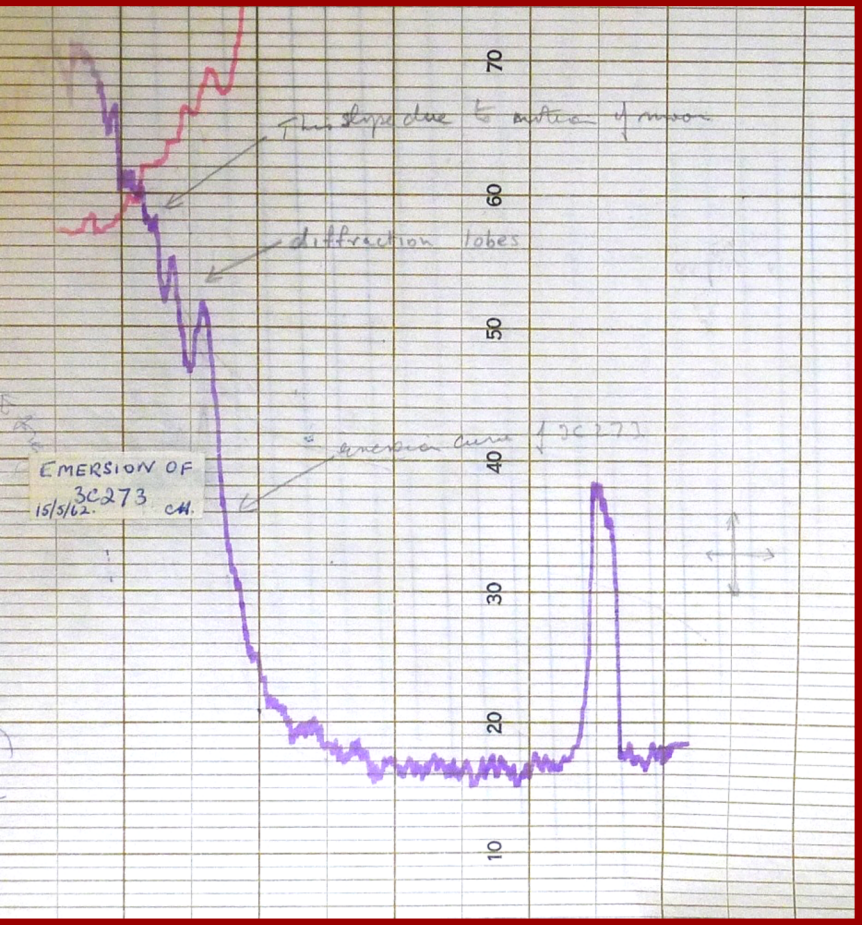
Parkes 64 m

Palomar 200"

1962 and the Three Parkes Occultations

- May 15 at 410 MHz saw the first ever diffraction fringes
- August 5 at 136 and 410 MHz, immersion & emersion
- October 26 at 410 and 1420 MHz, immersion only
- a big concentration on August and October

Between May and August John Bolton "attacked" the Dish,
but that's another part of this story……

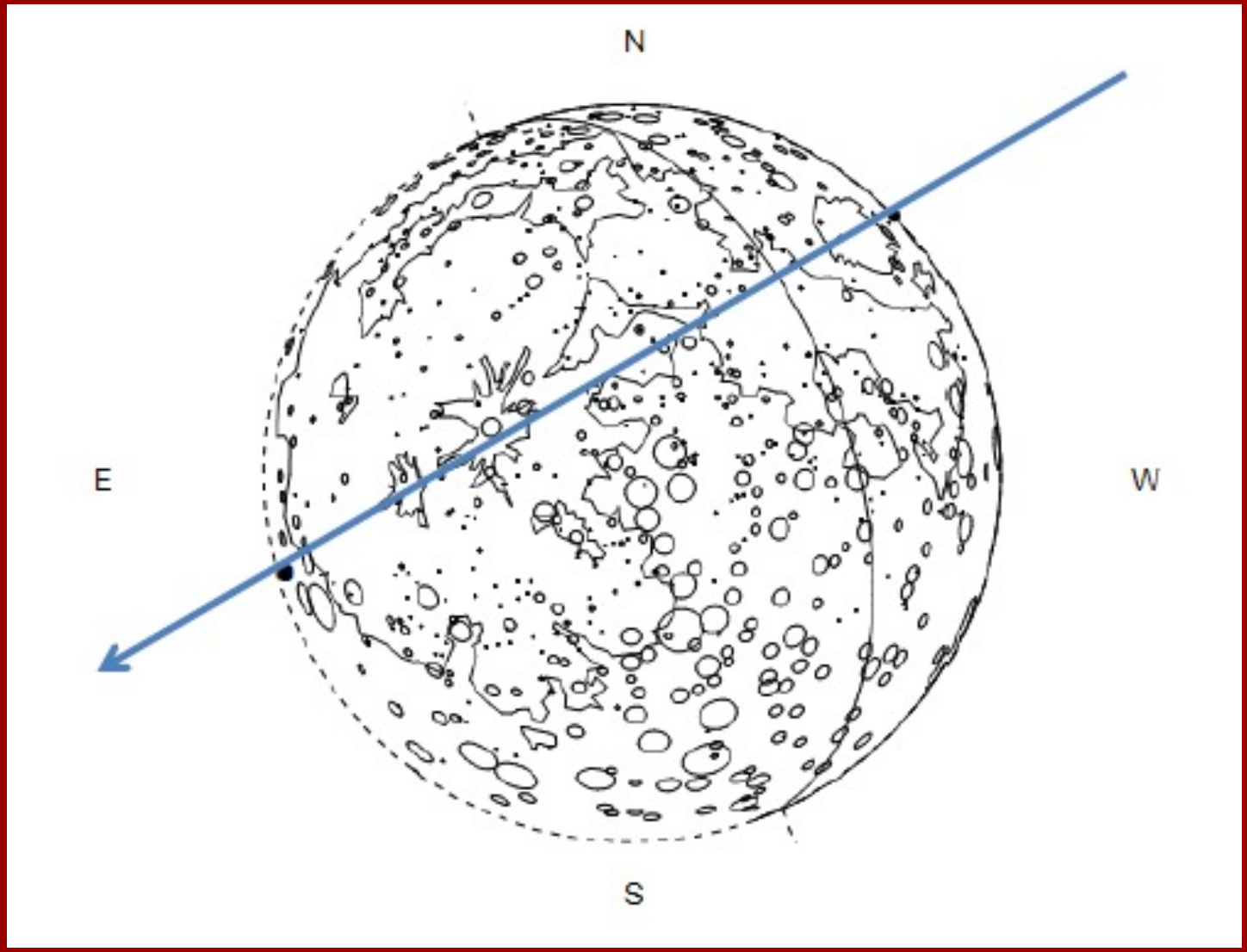


The May 15 Parkes occultation record at 410 MHz with the telescope stationary.

The rapid increase in the received noise level can be clearly seen, as the moon moved into the beam. The plot is taken from Hazard's records. The diffraction fringes can be seen clearly but the record was deemed unsuitable for a more detailed analysis.

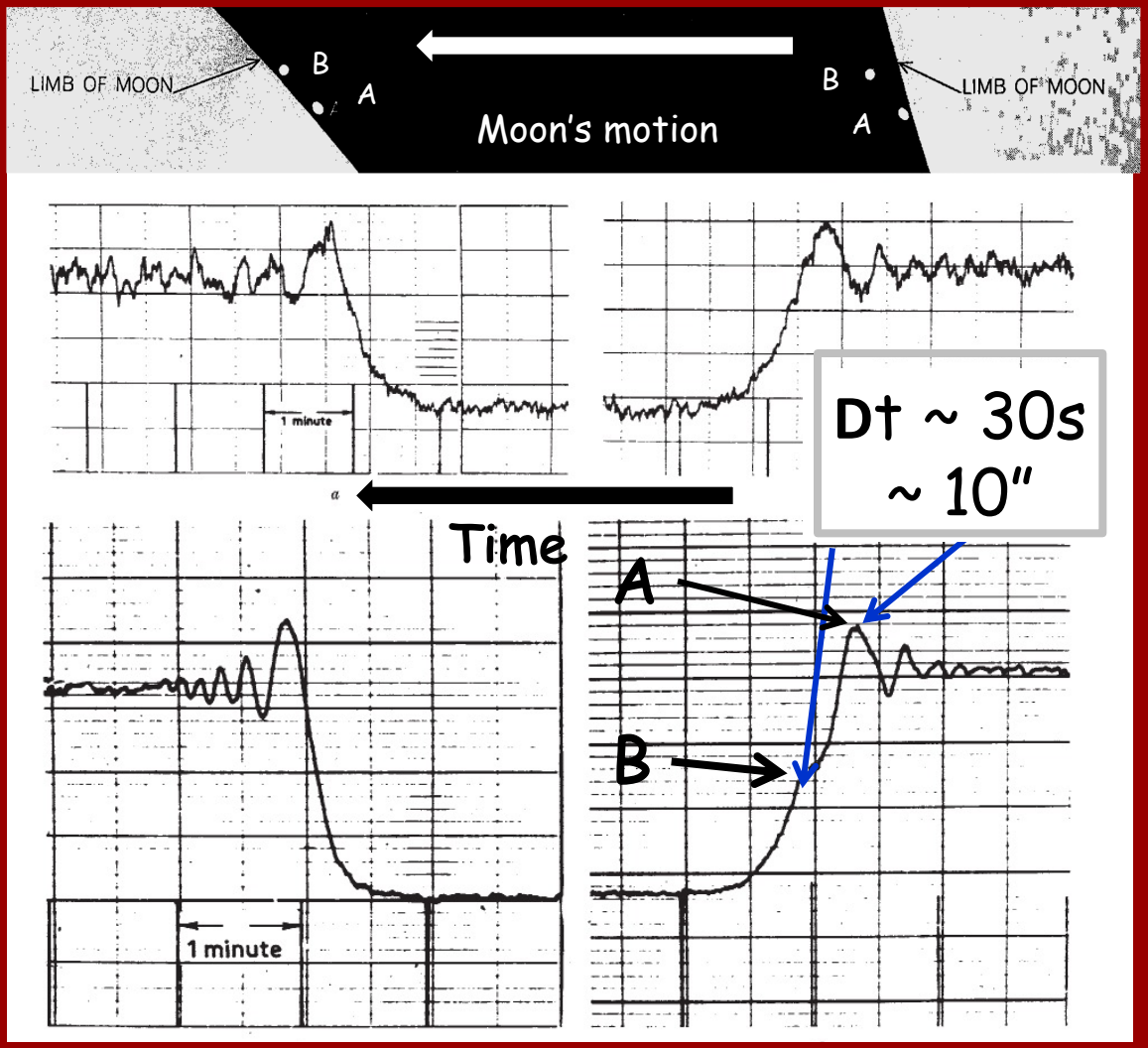
But it did make clear the importance of the upcoming August 5 occultation for which both disappearance and reappearance would be accessible.

<< time increases from right to left



The path of 3C273 disappearance and reappearance for the August 5 occultation

August 5, 1962 occultation



3C273 is clearly a double source at 410 MHz, aligned so that both components reappear together along P.A. 45 degrees

On August 20, after a meeting with Hazard and Minkowski, John Bolton wrote to Maarten Schmidt, and as a "by the way" noted the following coordinates for 3C273

(a)	12^h	26^m	$32^s.1$	$\pm 0^s.1$
	02°	$19'$	$30''.1$	$\pm 0''.2$
(b)	12	26	$32^s.5$	$\pm 0^s.1$
	02	19	$37''.3$	$\pm 0''.2$

With a postscript……

P.S The position of 273 is subject to arithmetic errors as yet undetected!

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This was just two weeks after the August observations, and was the first-time fringes had been analysed, so there was not enough time for Hazard to have communicated with Nicholson.

At 136 MHz there appears to be only a single source, which was Hazard's measured position.

The 410 MHz August record shows the basic double structure, apparent because of the overlapping 'fringes' in both the disappearance and the reappearance. Hazard measured the mean position for the disappearance, and the combined reappearance time.

These were the two 'positions' passed on to Bolton.

Note however, these is no mention of "Hazard" at all in the Schmidt letter……

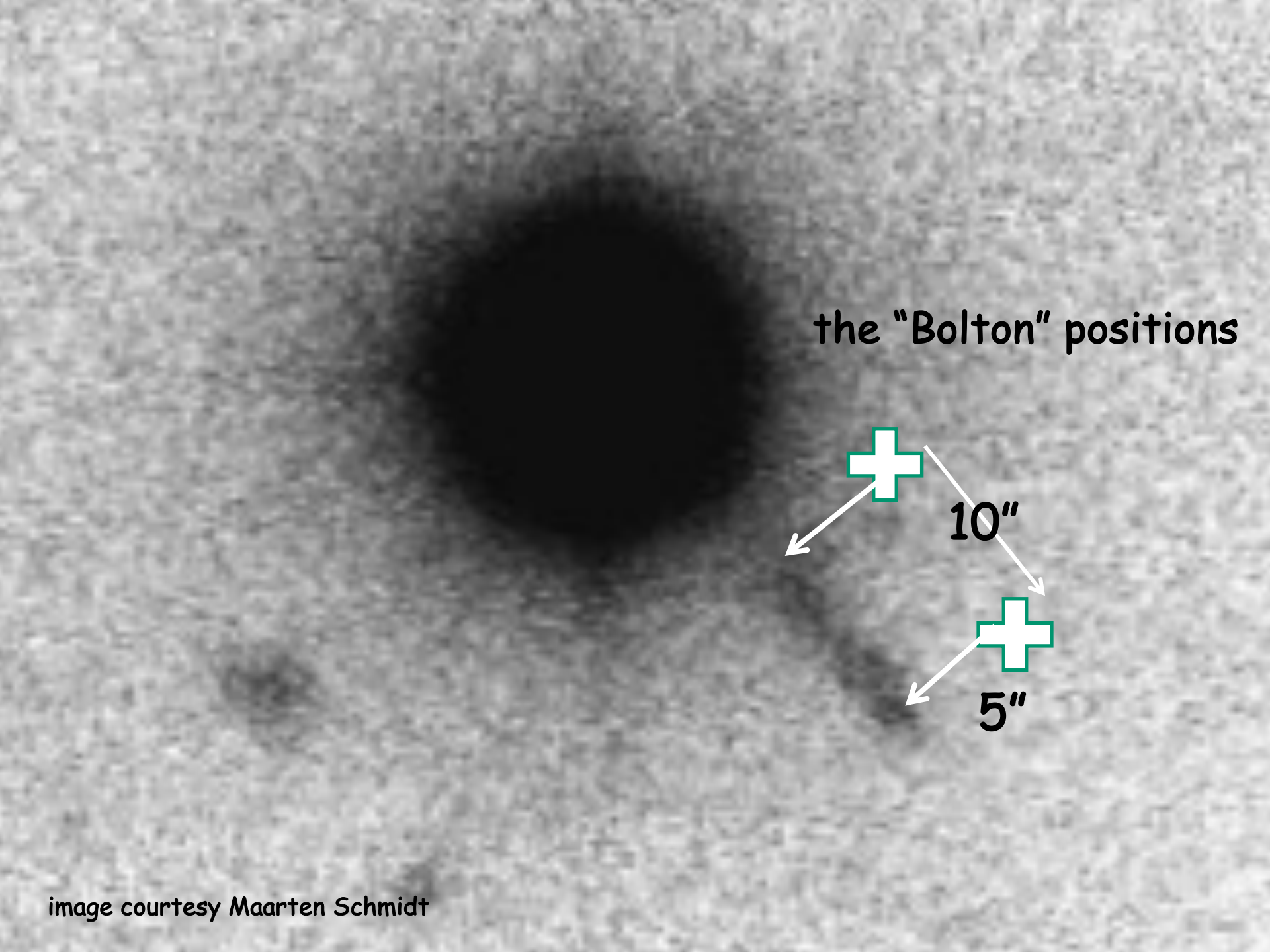
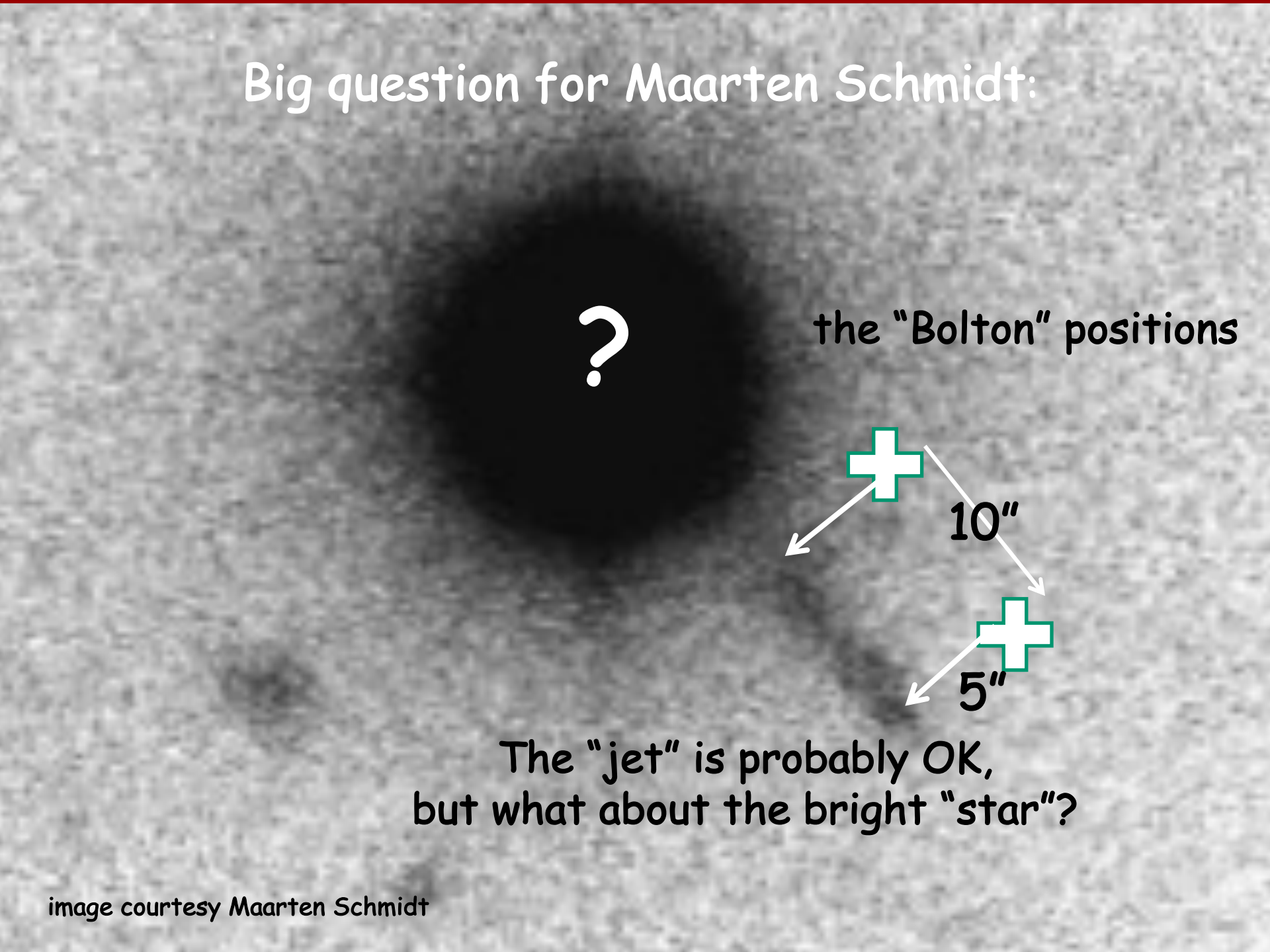


image courtesy Maarten Schmidt

Big question for Maarten Schmidt:



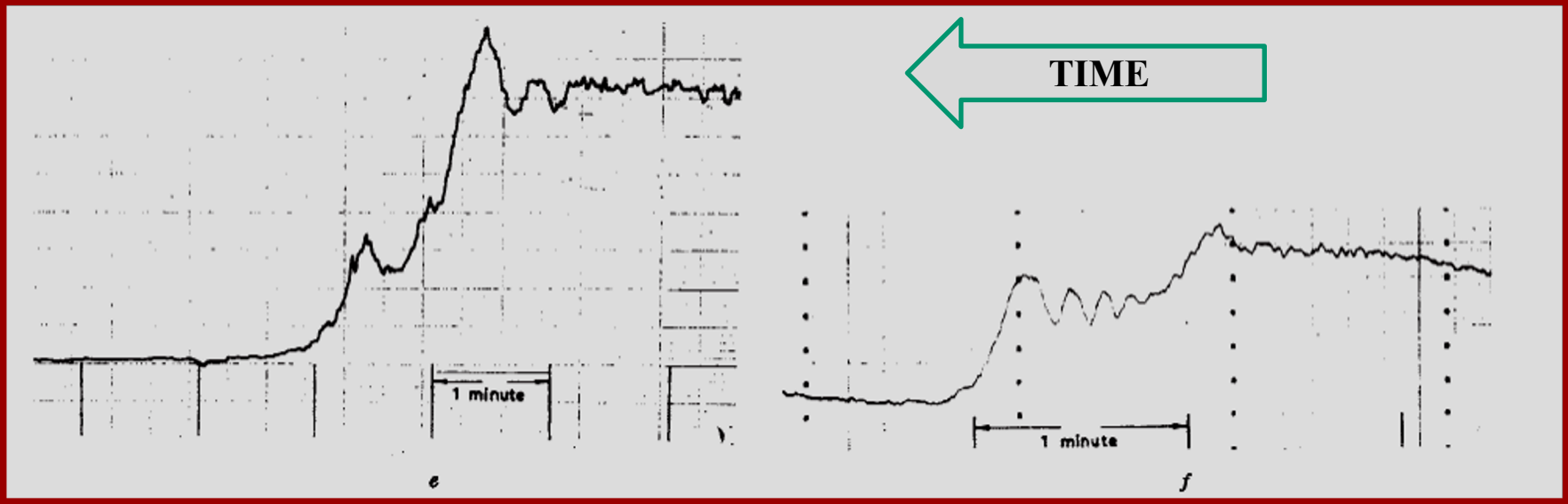
The "jet" is probably OK,
but what about the bright "star"?

image courtesy Maarten Schmidt

For Maarten this was unimportant at the time since 3C273 was not going to be accessible at Palomar until late December.

However, Maarten was very concerned that the 13th magnitude object was an unrelated foreground star, and so his major problem was first to observe its spactrum as it was gloing to spill into his later spectrum of the faint 'galaxy', which he thought was the likely identification.

The Parkes occultation, immersion only, of October 26 1962



Immersion at 410 MHz Immersion at 1420 MHz

What is interesting at 1420 MHz is the change in the flux density ratio of the two components with frequency. The spectral index of component B, the more compact, is flat at 0.0, whereas that of component A is steep at -0.9. Examination of the August '62 record shows component A totally dominates at 136 MHz and is ~95% of the total.

For both August and October 1962, Hazard's 3C273 analysis had revealed a "core-jet" structure

January 31st 1963 Hazard wrote to Schmidt with the correct occultation positions for A and B, and suggested a joint publication.

This core-jet radio structure now coincided very closely with the optical image. Component B is now clearly the bright STAR!

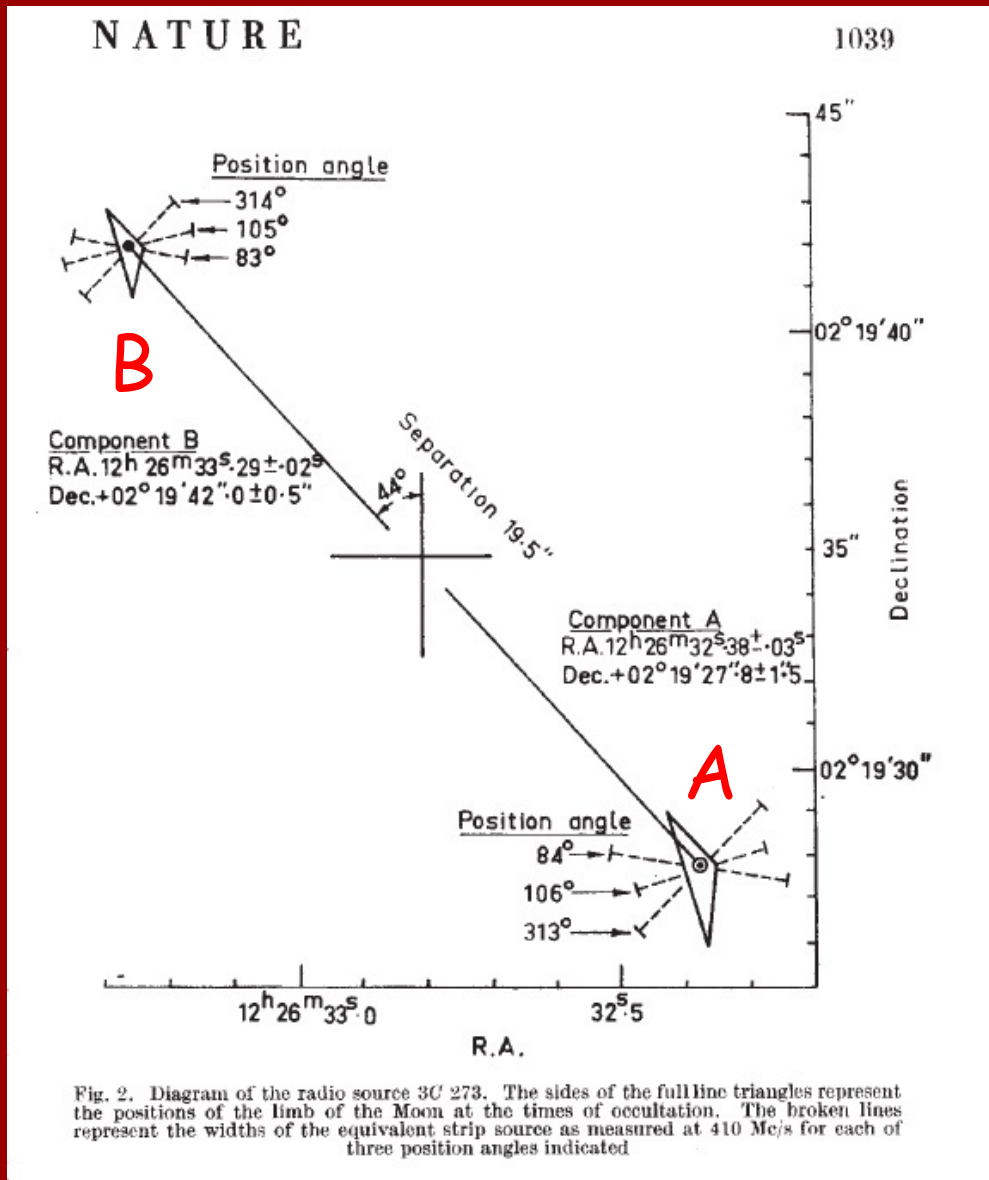
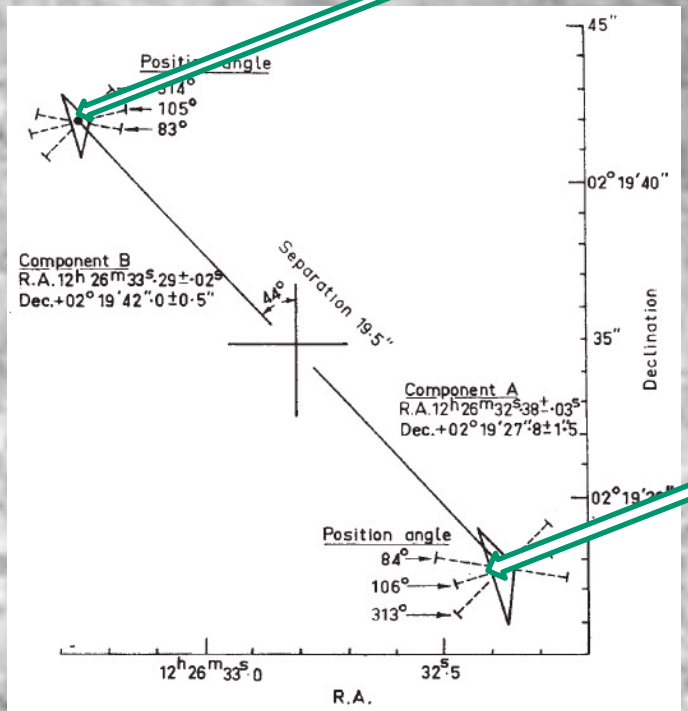


Fig. 2. Diagram of the radio source 3C 273. The sides of the full line triangles represent the positions of the limb of the Moon at the times of occultation. The broken lines represent the widths of the equivalent strip source as measured at 410 Mc/s for each of three position angles indicated

Component B



Component A

Observing cage 200-inch telescope
late December 1962

courtesy Maarten Schmidt

It happened on 6 February 1963. In response to Hazard's letter I decided to have another look at the spectra…..

For reasons that I don't remember I tried to construct an energy-level diagram. When the energy levels did not come out regularly spaced, I was annoyed….. To check on the regularity of the observed lines, I decided to compare them with the Balmer lines of hydrogen….

Specifically, I took for each line in 3C 273 the ratio of its wavelength over the wavelength of the nearest Balmer line. The first ratio was 1.16, the second was…..also 1.16.

It suddenly struck me that I might be seeing a redshift. When the third and fourth ratios were also close to 1.16, it was abundantly clear that I was seeing in 3C 273 a redshifted Balmer spectrum.

Maarten Schmidt, Proc. Amer. Phil. Soc., 155, 145, 2011

Maarten's 200" spectrum taken December 29 December 1962

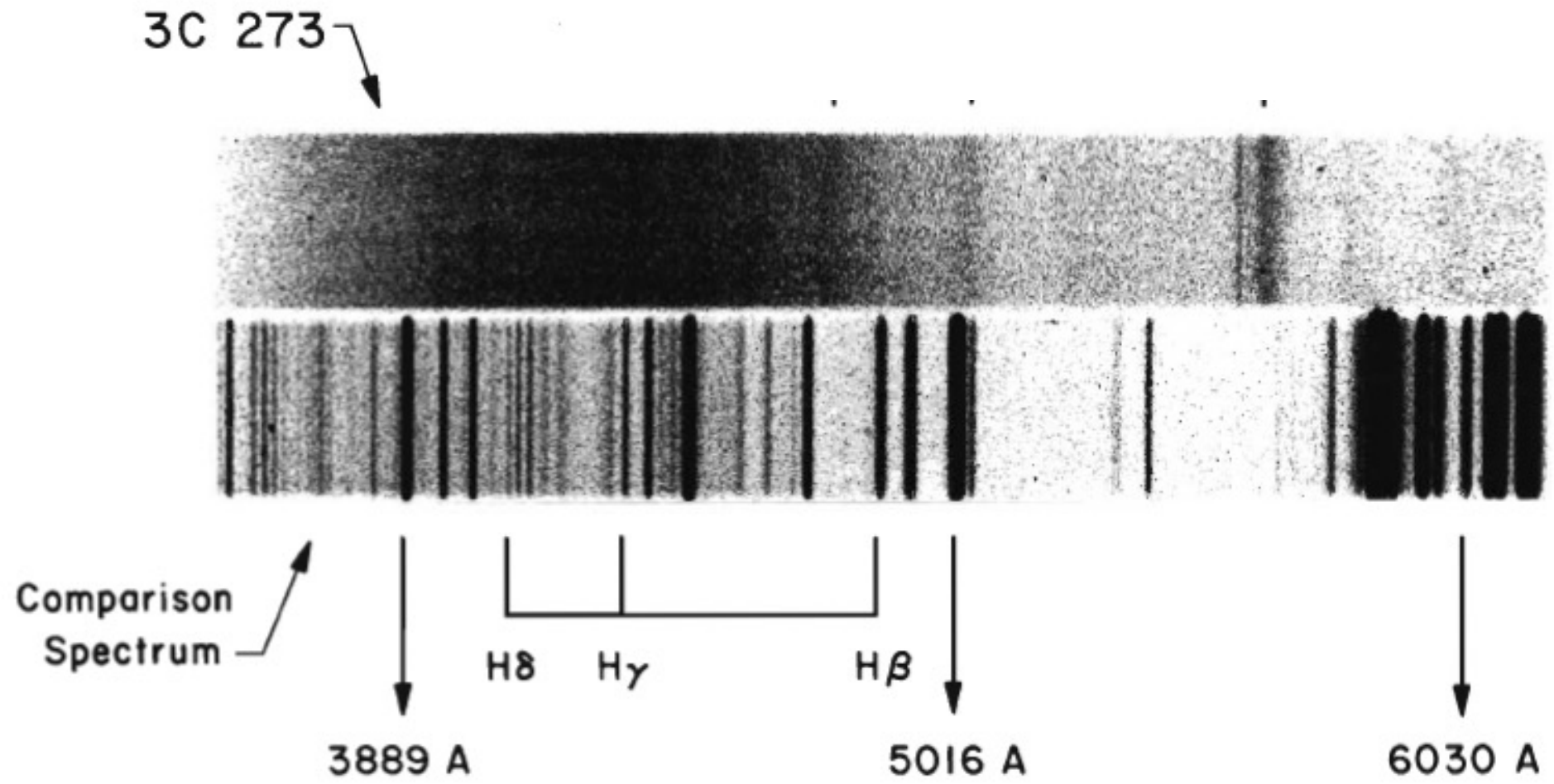


image courtesy Maarten Schmidt

He'd been puzzling over it. But on February 6

z = 0.16

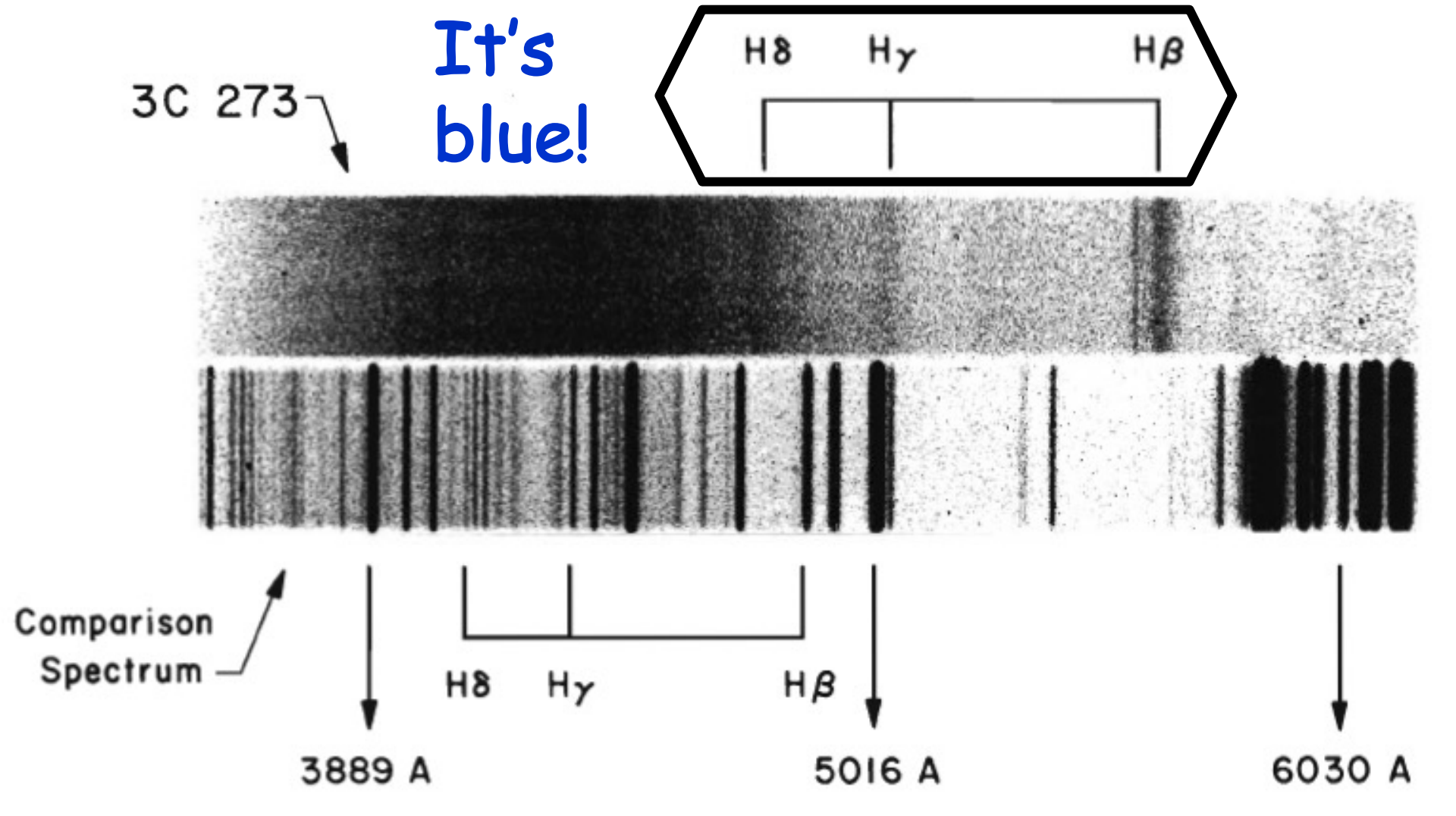


image courtesy Maarten Schmidt

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INVESTIGATION OF THE RADIO SOURCE 3C 273 BY THE METHOD OF LUNAR OCCULTATIONS

By C. HAZARD, M. B. MACKEY and A. J. SHIMMINS
C.S.I.R.O. Division of Radiophysics, University Grounds, Sydney

THE observation of lunar occultations provides the most accurate method of determining the positions

spond to spectral indices for components A and B of $-0{\cdot}9$ and $0{\cdot}0$ respectively. The spectral index of A is a

3C 273 : A STAR-LIKE OBJECT WITH LARGE RED-SHIFT

By DR. M. SCHMIDT
Mount Wilson and Palomar Observatories, Carnegie Institution of Washington, California Institute of Technology, Pasadena

THE only objects seen on a 200-in. plate near the positions of the components of the radio source 3C 273 reported by Hazard, Mackey and Shimmins in the preceding article are a star of about thirteenth magnitude and a faint wisp or jet. The jet has a width of 1″–2″ and extends away from the star in position

Table 1. WAVE-LENGTHS AND IDENTIFICATIONS

λ	$\lambda/1{\cdot}158$	λ_0	
3239	2797	2798	Mg II
4595	3968	3970	Hϵ
4753	4104	4102	Hδ
5032	4345	4340	Hγ
5200–5415	4490–4675		
5632	4864	4861	Hβ

With the discovery of the first quasar our knowledge and understanding of the Universe changed forever.

3C273:

- The first Quasar
- The first radio Jet
- The first inverted spectrum radio source
- The first sub-arcsecond radio position
- The first sub-arcsecond radio structure
- The first radio-optical reference frame tie
- The first radio and optical variable extragalactic source
- The first black hole

In memory
60 years on