

Ancient Light

Quasar PS1 J161737+595020

Ancient Light

Imaging a quasar **without a telescope**

Nikon D7500
300mm f/4 lens
256x30s exp

Redshift $z = 4.315$
Light-travel time = 12.4 billion years
Distance now = 24.6 billion light-years

iOptron SkyTracker

Dr Steve Barrett

BA Soc 7 Sep 2020

The Challenge

The Universe is vast and ancient. Large telescope have imaged galaxies that are billions of light-years distant.

Is it possible to capture an image of one of these very remote objects **without** a telescope?

(Spoiler alert: Yes, it is)

2

Quasar Survey

THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 243:5 (35pp), 2019 July
© 2019. The American Astronomical Society. All rights reserved. <https://doi.org/10.3847/1538-4365/ab2040>

The Extremely Luminous Quasar Survey in the Pan-STARRS 1 Footprint (PS-ELQS)

Jan-Torge Schindler^{1,2}, Xiaohu Fan¹, Xue-Hsin Huang¹, Minghao Yue¹, Jinyi Yang¹, Patrick B. Hall¹, Lukas Wenz¹, Allison Hughes¹, Katrina C. Litke¹, and Jon M. Rees¹

A **quasar** is the nucleus of a galaxy that emits enough light to be seen at a distance of billions of light-years

parent sample of 74,318 sources. After exclusion of known sources and rejection of candidates with unreliable photometry, we have taken optical identification spectra for 290 of our 334 good PS-ELQS candidates. We report the discovery of 190 new $z \geq 2.8$ quasars and an additional 28 quasars at lower redshifts. A total of 44 good PS-ELQS candidates remain unobserved. Including all known quasars at $z \geq 2.8$, our quasar selection method has a selection efficiency of at least 77%. At lower declinations, $-30 \leq \text{decl.} \leq 0$, we approximately treble the known population of extremely luminous quasars. We provide the PS-ELQS quasar catalog with a total of 592 luminous quasars ($m_i \leq 18.5$, $z \geq 2.8$). This unique sample will not only be able to provide constraints on the volume density and quasar clustering of extremely luminous quasars, but also offers valuable targets for studies of the intergalactic medium.

Key words: galaxies: nuclei – quasars: general

3

Quasar Survey

THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 243:5 (35pp), 2019 July
© 2019. The American Astronomical Society. All rights reserved. <https://doi.org/10.3847/1538-4365/ab2040>

The Extremely Luminous Quasar Survey in the Pan-STARRS 1 Footprint (PS-ELQS)

J161737.77 + 595020.1
 $z \approx 4.315$
Redshift

This peak has been redshifted from 1200 to 6500 Å

A redshift of 4.315 means that this quasar is VERY remote!

4

Ancient Light

Camera and Tracker

iOptron
SkyTracker

The tracker rotates the camera at 1 rev/day to follow the stars



Nikon D7500
300mm f/4 lens

Camera and Lens

Note: The Nikon D7500 digital SLR camera and 300 mm f/4 lens are the camera equipment that I use for wildlife photography – they are not 'special' or 'customised' for astrophotography.

If this camera and lens can be used to photograph zebras ...

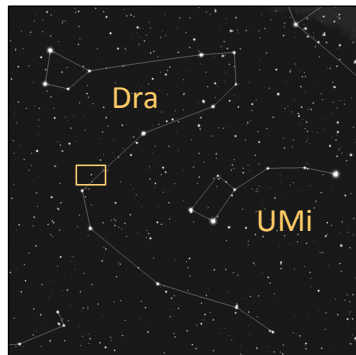


... can they also be used to photograph a quasar?

Location in Draco

The quasar is located in the constellation of Draco.

The rectangle shows the field of view of the 300 mm lens.



Expose For 2 Hours



Rather than take one 2-hour-long exposure
lots of shorter exposures were added together

Ancient Light

The Quasar

Most of the light from the quasar is focussed into one pixel

Just a pixel of the 20 Megapixel image

UNIVERSITY OF LIVERPOOL

9

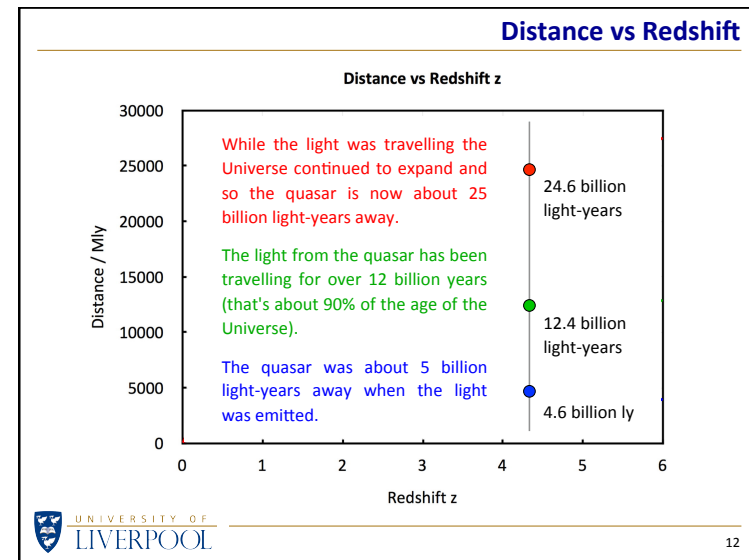
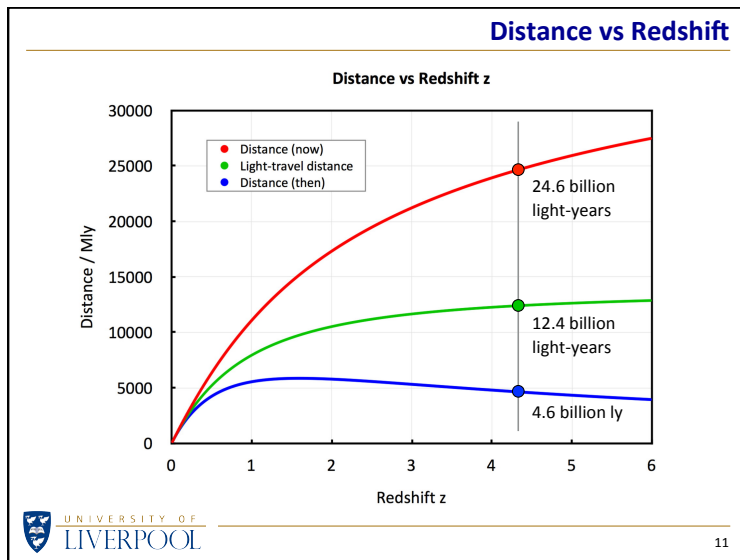
Barrett Deep Field

This 8' x 8' crop contains at least 10 galaxies ...

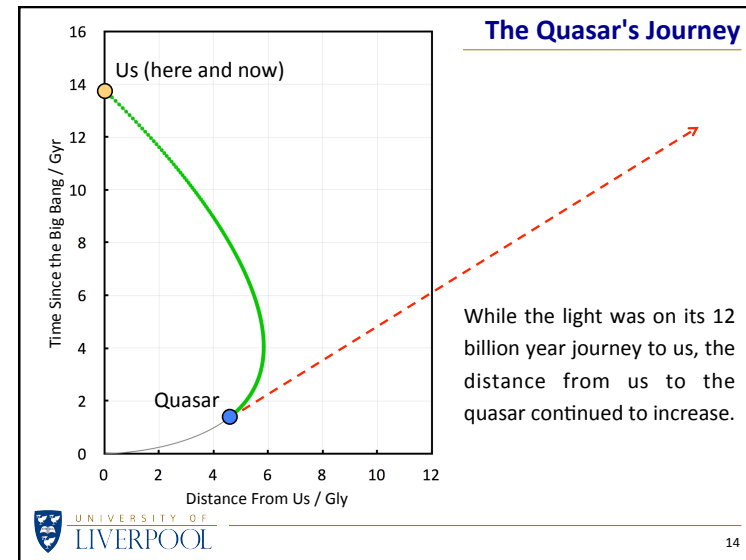
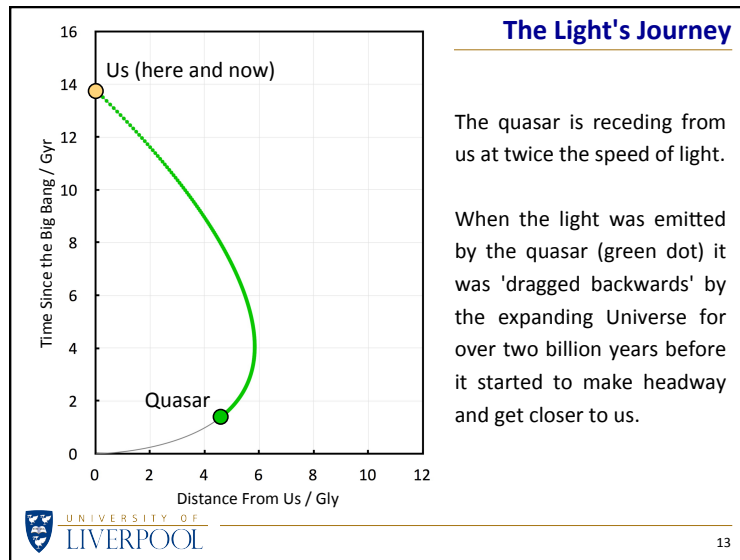
... so the full image may have captured about 7000 galaxies.

UNIVERSITY OF LIVERPOOL

10



Ancient Light



Ancient Light

The light was emitted by the quasar 1.4 billion years after the Big Bang. It had already been travelling for nearly 8 billion years when the Sun and the Earth were born. It continued on its journey through the void for another 4.5 billion years.

Life evolved on Earth. The light travelled on.

Dinosaurs came and went. The light travelled on.

In the last million years of its journey it arrived at the edge of our Milky Way galaxy, crossed a few spiral arms, and entered the Solar System.

In its last few hours it finally arrived at Earth, travelled through the atmosphere in a fraction of a second, hurtled towards England, dodged a few clouds, and entered the lens and hit the camera sensor.

Just a pixel in the image, but what a journey!

UNIVERSITY OF LIVERPOOL

15

Quasar PS1 J161737+595020

Dra UMi

Ancient Light

www.liverpool.ac.uk/~sdb/Talks

Nikon D7500
300mm f/4 lens
256x30s exp.

Redshift $z = 4.315$
Light-travel time = 12.4 billion years
Distance now = 24.6 billion light-years

iOptron SkyTracker

Dr Steve Barrett

BASoc 7 Sep 2020