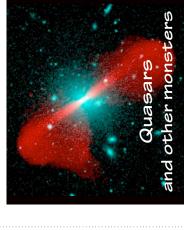
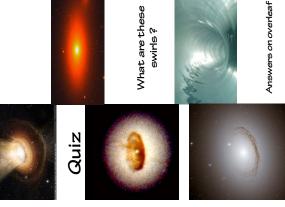
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4



The Universe in my pocket



important but difficult task Trying to find very distant quasars is an

and the UKIRT Infrared Deep Sky Survey with both the Sloan Digital Sky Survey This image was created from data taken

ordinary stars in our own galaxy. the other sources, most of which are the colour distinguishes the quasar from indicated by the two white lines). Only J1120+0641 (the faint red source distant quasar known so far, ULAS It allowed the discovery of the most

+

Vhat we do not understand

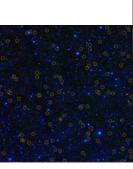
question is how the supermassive Perhaps the most important need to be solved questions about quasars that There are still many important

black holes were created.

so quickly after the birth of the mass of the Sun could have formed black hole with two billion times the after the Big Bang. Several was emitted only 800 million years distant one, ULAS J1120+0641, distances and the light from them can be detected at very large scenarios try to explain how a takes a long time to reach us. The Quasars are so luminous that they light we receive from the most

Quasars in the Universe





circles. quasar candidates are inside the yellow might be quasars. In this image the has identified millions of objects that The Wide-field Infrared Survey Explorer

Chandra, Hubble, and Spitzer space telescopes

Composite image of the 3C273 jet (100,000 light-years long) in X-rays (blue), visible (green) and infrared (red) by the

probe the matter out to the extreme luminous, their spectra allow us to edges of the Universe.

awaiting confirmation and many more Present quasar catalogues based on Because quasars are intrinsically so optical discoveries contain about 300,000 objects. But there are already millions of candidates to come with future surveys.

in orange and the optical image of the galaxy

is in white.

Right: Hubble Space Telescope image of the

central zone showing a disk of dust 400

light-years across.

radio lobes (200,000 light-years long) are

Composite image of NGC 4261. Left: the

galaxies contain a supermassive black between periods of 'hibernation' with matter that passes too close to it. stages of intense 'activity' during hole. Galaxies probably alternate which the black hole devours the Astronomers now think that <u>all</u>

astronomers can see details not visible with telescopes on Earth. With the Hubble Space Telescope,

originate. We can now distinguish the shapes of the galaxies from which the radio jets

point away from the galactic nucleus. cases, optical `jets' are seen to zones of the nearest ones. In some Dusty disks are seen in the central

X-ray sources. and their related galaxies are bright X-ray telescopes show that quasars

called radio-quiet quasars. not emitting radio waves. These are the same properties as quasars but In the meantime, though, astronomers have discovered many objects with

characteristic spectra of quasars. This radiation interacts with the surrounding gas, producing the

producing ultraviolet light and X-rays. hole, that attracts whatever matter in their center a supermassive black More massive black holes are more heated to very high temperatures, black hole, the matter spirals down onto an 'accretion disk', where it is lies nearby. Before falling into the uminous.

smaller than one galaxy. How can this energy per second as 1000 galaxies, be? Clearly the origin of the radiation Typically, quasars radiate as much but from a region a million times cannot be stellar.

It is now accepted that quasars host

How quasars work



<-rays.

galactic nuclei, ie. some Seyfert in 1943 and galaxies described by now considered the archetype of active sort of mini-quasar.



the observer

Arp220, an ultraluminous A visible light image of

but hardly detectable in the visible. Recently, infrared observations of galaxies very bright in the infrared the sky revealed a population of Many of these are thought to contain active galactic nuclei.

blazars. In all cases, a central black galaxies. They belong to the class more massive and more luminous. nuclei and unusual spectra. Such Before quasars were discovered, hole is accreting matter from its which also includes quasars and of 'galaxies with active nuclei', surroundings, but quasars are galaxies have especially bright galaxies were named Seyfert we already knew that some

Other monsters

surroundings of the massive black hole in NGC 3783 How an artist imagines the

3C405

Right:

HST image of the galaxy

NGC 1277 that

3C405

brightest radio image of one of the A modern radio

sources in the sky:

visible light

image of Telescope Space

contains an extremely massive black hole Disk of cold gas and

observed with the central black hole dust fueling the of the galaxy NGC 4261

3C31

quasar.

3C405 and hosting a

two radio lobes of located between the Cygnus A, the galaxy



N

3C31originate.

radio lobes of from which the NGC 383, the galaxy

Right:

3C31.

radio source eft: The

The Universe in my pocket No.

UNAM Radio Astronomy Institute in Morelia (France) and revised by Stan Kurtz from the Grażyna Stasińska from Paris Observatory This booklet was written in 2016 by

in blue) and of the jets of the radio source massive elliptical galaxy NGC 5532 (shown from HST, CXC, SAO, Spitzer and UKIRT. telescopes. Other images in this booklet are created with the Very Large Array of radio 3C296 (shown in red). The radio map was Cover image: a composite image of the



series and about the topics Toleam more about this presented in this booklet, please visit

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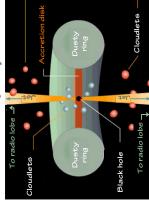
showing its circula

dust lanes

black hole, perpendicular to the accretion disk They end up in radio lobes, up to one million Jets of fast particles originate from the ight-years in size.

The disk connects to a fat, dusty ring of radius 1000 light-years. If the dusty ring is edgeon, the accretion disk is hidden from view.

hole. The disk emits radiation which interacts disk (radius 1 light-month) fuelling the black hour) is surrounded by a thin, hot accretion A supermassive black hole (radius 1 lightwith the neighbouring gaseous cloudlets.



The anatomy of a quasar

years ago. they were only discovered about 60 luminous objects in the Universe, Although quasars are the most

occupied by faint, stellar-like blue extended radio sources were that the central zones of many the radio sources, they discovered tried to find visible light matches to at that time. When astronomers sources had already been recorded Radio signals from many celestial

quasi-stars). and they were not stars. They distant than many known galaxies) away (well outside our galaxy, more revealed that they were very far received the name of quasars (for The spectra of these objects S