A Method for Predicting Quasar Luminosity Consistent With the NASA/IPAC Extragalactic Database

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Abstract

It is widely accepted that quasar radiation is emitted from a thick torus shaped accretion disk surrounding a black hole. However, the Chandra X-ray Observatory wide field panorama released on March 12, 2007, indicates many quasars do not have an accretion disk and cannot be explained by this representation. A solution is presented that does not require or exclude an accretion disk. It is based on the method first suggested in the 2004 APS Four Corners Section Fall Meeting presentation, "Wave Propagation in a Gravitational Field." This model makes it possible to predict quasar luminosity as a function of gravitational redshift in qualitative agreement with the population distribution recorded in the NASA/IPAC Extragalactic Database. Furthermore, it indicates conditions may become critical at a redshift of 3.5 causing a quasar to ignite in a form of radiation limited gravitational collapse. These results offer a possible explanation for a peak, at a redshift of 3.75, in the observed population distribution. The success of this approach provides convincing evidence that gravity is the primary influence behind both the radiant power and redshift of quasars.

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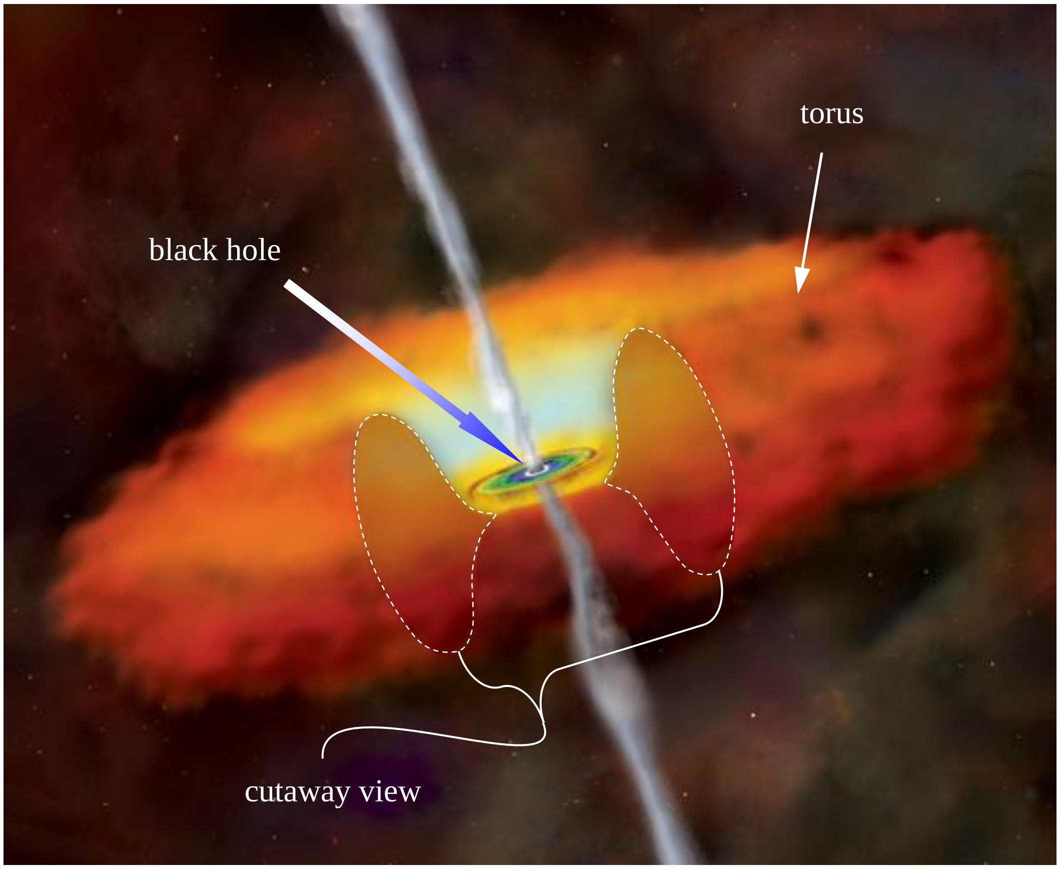
1. Introduction

Quasars have a high redshift and appear to be small. The redshift is measured directly from the quasar's electromagnetic spectrum. However, it is both the starlike appearance and the observed fluctuation in energy received over short time intervals from these celestial bodies that lead astronomers to conclude they are small. A popular theory explains these observations as follows:

- Quasar redshift is assumed to be caused by the relativistic Doppler effect associated with an expansion of the universe.
- Quasars are believed to be billions of light years away based on the idea that distance can be calculated from the measured redshift and the Hubble constant.
- Quasars are thought to be extremely luminous because we can detect them even though they appear to be small and are believed to be very far away.

This model has caused astronomers to puzzle over a quasar's apparent ability to emit enormous amounts of energy from a small area. A consensus has arisen that "black hole theory" makes this possible. Based on this concept, the tremendous amount of energy emitted from a quasar is created in an accretion disk that is a dense torus or doughnut-shaped region of gas surrounding a black hole as illustrated in Figure 1.

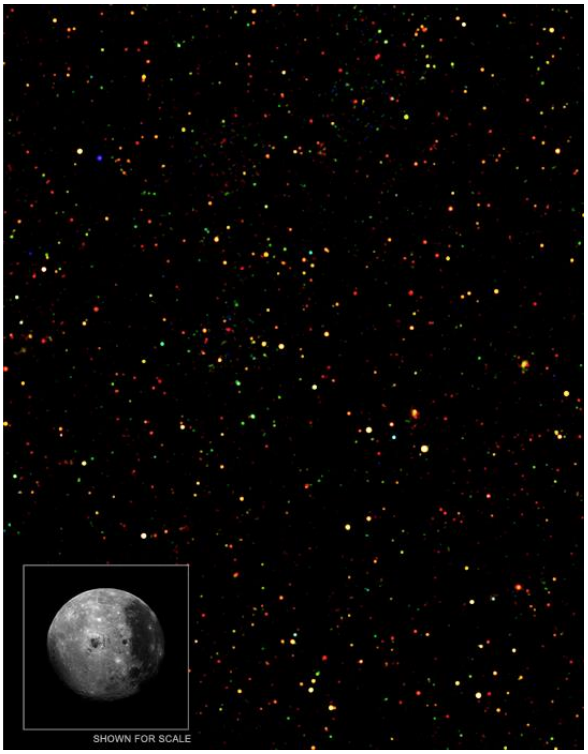


(Illustration by: NASA/CXC/M.Weiss. Arrows, lines, and text added by Morris Anderson)

Figure 1 This represents the “popular current model” of a quasar as a black hole with an accretion disk.

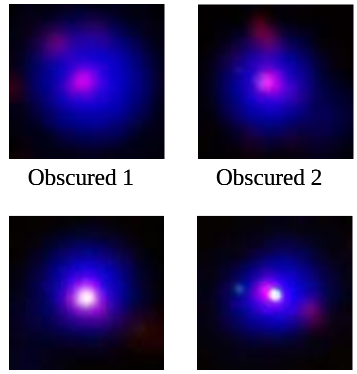
However, the Chandra X-ray Wide-field Panorama (see Figure 2) appears to invalidate this conclusion as described in the following excerpt from a news release dated March 12, 2007:

> The new survey raises doubts about a popular current model in which a supermassive black hole is surrounded by a doughnut-shaped region, or torus, of gas. An observer from Earth would have their view blocked by this torus by different amounts, depending on the orientation of the torus.
>
> According to this model, astronomers would expect a large sample of black holes to show a range of absorption of the radiation from the nuclei. This absorption should range from completely exposed to completely obscured, with most in-between. Nuclei that are completely obscured are not detectable, but heavily obscured ones are.
>
> "Instead of finding a whole range, we found nearly all of the black holes are either naked or covered by a dense veil of gas," said Hickox. "Very few are in between, which makes us question how well we know the environment around these black holes."
>
> This study found more than 600 obscured and 700 unobscured AGN, located between about six to 11 billion light years from Earth (see Reference 1).



X-ray: NASA/CXC/CfA/R.Hickox et al.; Moon: NASA/JPL

X-ray, IR & Optical Composites
of Obscured & Unobscured AGN
in Bootes Field



Obscured 1 Obscured 2

unobscured 1 unobscured 2

These images show four black holes from the Bootes field. The first two black holes are obscured by thick rings of gas. Because such a ring blocks certain types of radiation, these black holes are only are seen in X-ray (blue) and infrared (red) light. The last two black holes are not enshrouded by this ring of material, and, therefore, emit X-ray, infrared, and optical (green) radiation.

Figure 2 These pictures and words present a portion of the Chandra X-ray Wide-field Panorama news release published on March 12, 2007. (Credit: X-ray: NASA/CXC/CfA/R.Hickox et al.; Infrared: NASA/JPL/Caltech/P.Eisenhardt & D.Stern et al.; Optical: NOAO/B.Jannuzi & A.Dey et al.)

As explained in the Chandra news release, the wide field panorama presented in Figure 2 did not uncover the evidence astronomers were looking for to support their popular theory. On the contrary, it appears to have ruled out an accretion disk for many quasars and along with it the explanation for their radiant power!

2. In Search of a Solution and the Limitations of General Relativity

The Chandra data indicates that many quasars, which by the popular theory are interpreted to be black holes, do not have an accretion disk. This forces us to abandon the black hole theory and search for another explanation for their characteristics. However the following quote by Karl F. Kuhn indicates why a widely accepted alternative has not been developed within the context of general relativity:

> Einstein's general theory of relativity predicts that light leaving a massive object will be redshifted due to the mass of the object. Calculations show that in order to produce redshifts such as those seen in quasars, the gravitational field near the object must be far greater than that near the most massive neutron star, and well-grounded nuclear theory tells us that there is a limit to the mass of a neutron star. After a certain mass is reached, a neutron star cannot exist. A black hole is formed. The theory of relativity simply cannot be used to explain the redshift. (see Reference 2)

The prediction of a black hole is caused by a singularity contained in the general theory of relativity. It has become a serious roadblock preventing scientists from describing the behavior of matter under very strong gravitational conditions as illustrated in the following excerpt from the recent textbook, *Astronomy Today* ─*5*th *ed*. which states:

> General relativity predicts that, without some agent to compete with gravity, the core remnant of a high-mass star will collapse all the way to the point at which both its density and its gravitational field become

> infinite. Such a point is called a singularity. We should not take this prediction of infinite density too literally, however. Singularities are not physical ─ rather, they always signal the breakdown of the theory producing them. In other words, the present laws of physics are simply inadequate to describe the final moments of a star's collapse.
>
> As it stands today, the theory of gravity is incomplete, because it does not incorporate a proper (i.e., a quantum mechanical) description of matter on very small scales. As our collapsing stellar core shrinks to smaller and smaller radii, we eventually lose our ability even to describe, let alone predict, its behavior. (see Reference 3)

There is also another serious limitation in using the general theory of relativity. Previous efforts to extend the highly successful concept of wave-particle duality to the realm of gravity with general relativity have been unsuccessful. Furthermore, there appears to be a fundamental discontinuity between general relativity and nature preventing us from accomplishing this as illustrated in the following conclusion by Bahram Mashhoon:

> …a complete description of wave propagation does not appear possible in general relativity due to the existence of the curvature-induced lower limit on the wave number. A similar limitation does not apply to the momentum of a particle. Therefore, it does not appear possible to introduce in a natural way the hypothesis of wave-particle duality into the framework of general relativity. (see Reference 4)

Therefore, we are severely limited with what we can model with general relativity because it appears to be incompatible with wave mechanics and incapable of modeling the properties of a quasar. This roadblock seems to gives us no choice; we must search for another solution.

3. A Gravitational Solution

The book, *Time, Matter, and Gravity* (we will refer to this book and method as TMG - see Reference 5) presents a derivation that describes the fundamental characteristics of gravity based on the laws of conservation and the wave-particle duality of matter. This makes it possible to use wave mechanics for describing the motion of any object, wave, or particle in a gravitational field. TMG accurately predicts the gravitational bending of light, orbital precession, redshift, and Shapiro time delay (see Reference 5). In addition, TMG does not suffer the limitations that plague general relativity. Therefore, we can use it to calculate the luminosity of a quasar, the results of which are in qualitative agreement with data as illustrated in Figure 9.

3.1 Theoretical Approach

The following assumptions and steps make it possible to calculate the luminosity of a quasar with results that agree with data:

Assumptions

1. The observed quasar redshift is caused primarily by gravity.
2. Quasar emissivity (relative to a black body) is a function of the maximum surface emission angle, relative to radial, that will permit light to escape its influence.
3. The surface temperature of a quasar is a function of escape velocity.
4. The observed quasar population distribution, recorded in the NASA/IPAC Extragalactic Database, is proportional to luminosity.

Procedure for calculating luminosity

1. Calculate the change in the emissivity, mass, and volume of a quasar as a function of gravitational redshift with the method documented in the book, *Time, Matter, and Gravity*.
2. Calculate quasar luminosity using this information, based on black body radiation.
3. Compare the calculated luminosity with the observed population distribution recorded in the NASA/IPAC Extragalactic Database.

For this study, we limit our investigation to matter (in the form of a particle or electromagnetic wave) moving through the gravitational field of a single non-spinning governing body. We also restrict the amount of matter in motion to be much smaller than the governing body so that it does not significantly alter the gravitational field.

The equations required to calculate the luminosity of a quasar are presented in the following sections:

3.2 Quasar Redshift

Gravitational redshift, z, is defined in Figure 3 which also illustrates a significant difference between TMG and general relativity (GR). Based on TMG, we can use equation (1) to calculate the gravitational redshift.

$$z = \frac{1}{\sqrt{e^{\phi}}} - 1 \tag{1}$$

Where:

$$\phi = \frac{-2GM}{c_s^2 r}$$

G = Newton's gravitational constant
M = Mass of the governing body
r = The radial distance from the center of mass
c_s = The standard speed of light = 299 792 458 m/s

Note that e^{ϕ} has the Maclaurin series representation:

$$e^{\phi} = 1 + \phi + \frac{\phi^2}{2!} + \frac{\phi^3}{3!} + \cdots \tag{2}$$

The general relativity equation for the gravitational redshift is:

$$z = \frac{1}{\sqrt{1+\phi}} - 1 \quad \text{(general relativity solution)} \tag{3}$$

A comparison of equation (2) and (3) illustrates that the general relativity gravitational redshift contains a 1st order approximation of a natural exponential function! This appears to be a fundamental error contained in general relativity that does not significantly impact weak-field calculations.

Natural exponential functions are very common in nature of which typical solutions to the Schrödinger wave equation for atomic structure represent one example. Therefore, based on this observation alone we should anticipate equation (1) to be a more realistic solution than equation (3).

Figure 3 illustrates that, based on TMG, gravity can cause the redshift associated with high redshift quasars. It also describes why this is not possible with general relativity because it contains a singularity that is the basis for theoretical black holes.

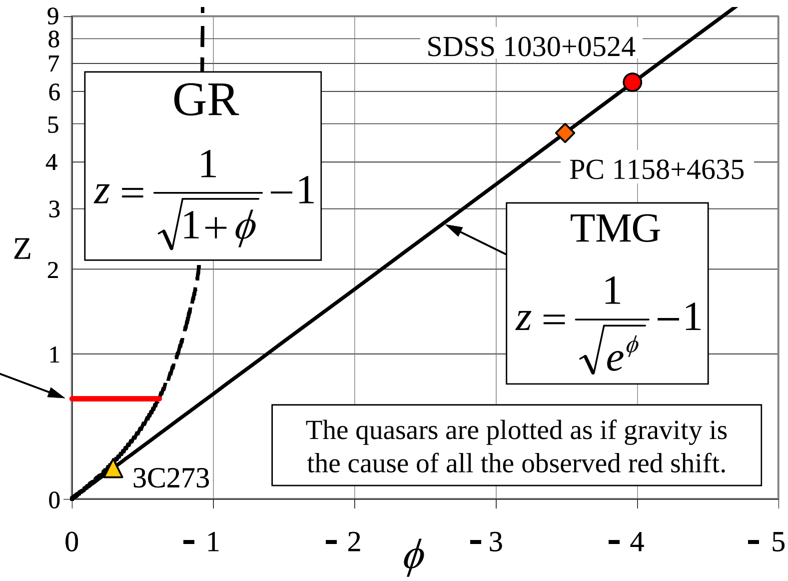
A review of Figure 3 clearly illustrates that both methods provide similar results for weak-field calculations. However, the TMG natural exponential solution indicates that the general relativity concept of a black hole is an illusion caused by a 1st order approximation.

The TMG natural exponential solution makes it possible to account for quasar redshift in terms of gravity.

General relativity (GR) limit for gravitational redshift as calculated by Hermann Bondi beyond which a black hole (singularity) is predicted to form.

The general relativity solution contains a 1st order approximation of the following Maclaurin series. This makes it singular.

$$e^{\phi} = 1 + \phi + \frac{\phi^2}{2!} + \frac{\phi^3}{3!} + \cdots$$



$$z = \frac{\lambda}{\lambda_\infty} - 1$$

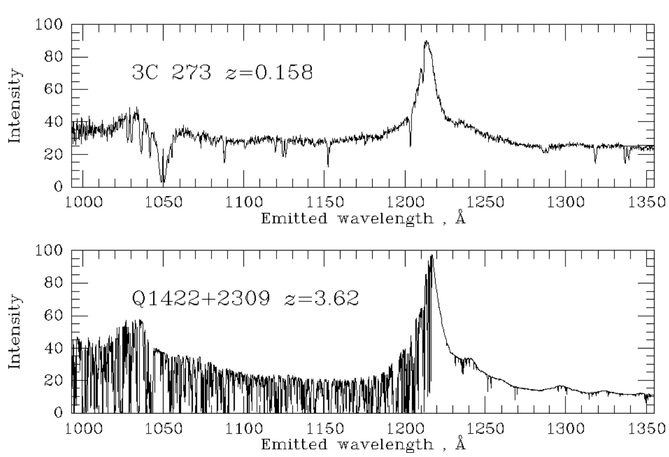
λ_∞ = Wavelength of photon created at r = ∞ by a reference oscillator.

λ = Wavelength of photon emitted by a reference oscillator located at *r* and measured at *r* = ∞

$$\phi = \frac{-2GM}{c_s^2 r}$$

Figure 3 TMG provides a gravitation explanation for the red shift of quasars

To date; scientific tests of general relativity have been limited to weak gravitational environments for conditions where ϕ is no less than about -0.1 as defined by equation (5). However, quasars provide us with the ability to test gravitational conditions that may be several orders of magnitude stronger. One of these tests could be with respect to absorption lines in the quasar spectrum. The popular theory states that these lines, referred to as the "Lyman-alpha forest", are caused by inter-galactic clouds of hydrogen (see Figure 4). However, based on TMG, they could instead be caused by the radiation passing through in-falling matter, rings, or an accretion disk associated with the quasar itself. As such, each absorption line would be associated with matter subject to the gravitational redshift corresponding with its proximity to the quasar. This is supported by the Chandra data that indicates many quasars are covered by a dense veil of gas. Therefore, this approach provides a very reasonable explanation of the Lyman-alpha forest data that should be investigated in more detail.



The words and data presented in this figure were obtained from Bill Keel's website at: http://www.astr.ua.edu/keel/agn/forest.html
Email: keel@bildad.astr.ua.edu

This panel compares two quasars at very different redshifts, 3C 273 at z=0.158 and 1422+2309 at z=3.62, shifted to a common scale in emitted wavelength. The strong and broad emission peak is Lyman alpha, which is almost chopped in half by the onset of the Lyman alpha forest in the high-redshift quasar. At low redshift, 3C 273 shows only a handful (but distinctly more than zero) Lyman alpha absorbers, including the strong and broad absorption from its light intercepting the disk of a foreground spiral galaxy (ours).

Figure 4 The Lyman-alpha forest

3.3 Quasar Emissivity

The emissivity of a quasar is a function of the minimum emission angle, relative to radial, that is required for light to escape from its influence. TMG provide a very simple method for calculating this information. The following description briefly illustrates how to do this. However, the reader is encouraged to study the full derivation as originally published in TMG to gain a better understanding of the concepts involved.

The TMG wave propagation method is established on the principle of wave-particle duality. According to this principle, as matter changes position in a gravitational field, the properties of space alter its wavelength causing it to follow a curved path. The resulting curved path solution is somewhat similar to the general relativity concept of space-time curvature. However, the TMG method provides a natural exponential solution that overcomes the limitations associated with general relativity. This makes it possible for us to calculate the emissivity of a quasar as a function of gravitational redshift.

As derived in TMG, the speed of light in the gravitational field of a single none-spinning governing body is a function of position as given by equation (4), see Figure 5.

$$c_2 = c_1\, e^{\left(\frac{2MG}{c_s^2}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)\right)} \tag{4}$$

Where:

c = The speed of light at a distance of r from the center of matter of the governing body.
c_∞ = The speed of light at an infinite distance from the governing body.
See equation (1) for a definition of the other variables.

$$For\ r_1 = \infty,\ \ r = r_2,\ \ c_2 = c: \qquad \phi = \frac{-2MG}{c_s^2 r} \tag{5}$$

$$c = c_\infty\, e^{\phi} \tag{6}$$

Note: If we use a non-local experiment such as the gravitational bending of light or redshift we can easily detect the variation in the speed of light as given by equation (4). However, even though the speed of light is a function of the properties of space, TMG predicts that this does not affect the relationship between the speed of light and the charge, rest mass, or structure of matter. For example, if we compare the natural frequency of an atomic clock to the length of a ruler in a laboratory using any means at our disposal, TMG predicts the results to be independent of time, velocity, and the location of the laboratory. Similarly, the variation in the speed of light in a gravitational field does not alter the fine structure constant.

If no other influence is involved, the variation in the speed of light, see equation (4), alters the velocity and wavelength of matter passing through a gravitational field according to equations (7) through (9).

$$\lambda_2 = \lambda_1 \frac{\beta_1}{\beta_2} e^{\phi}\ ; \quad \beta = \frac{v}{c} \tag{7}$$

$$\phi = \frac{2MG}{c_s^2}\left(\frac{1}{r_1} - \frac{1}{r_2}\right) \tag{8}$$

$$\beta_2 = \frac{v}{c} = \sqrt{1 - e^{\phi}\left(1 - \beta_1^2\right)} \tag{9}$$

These equations make it possible to calculate an object's motion through a gravitational field as illustrated in Figure 5. In summary, the object's curvature of motion is a function of the influence of the gravitational field on its wavelength and non-dimensional velocity, β.

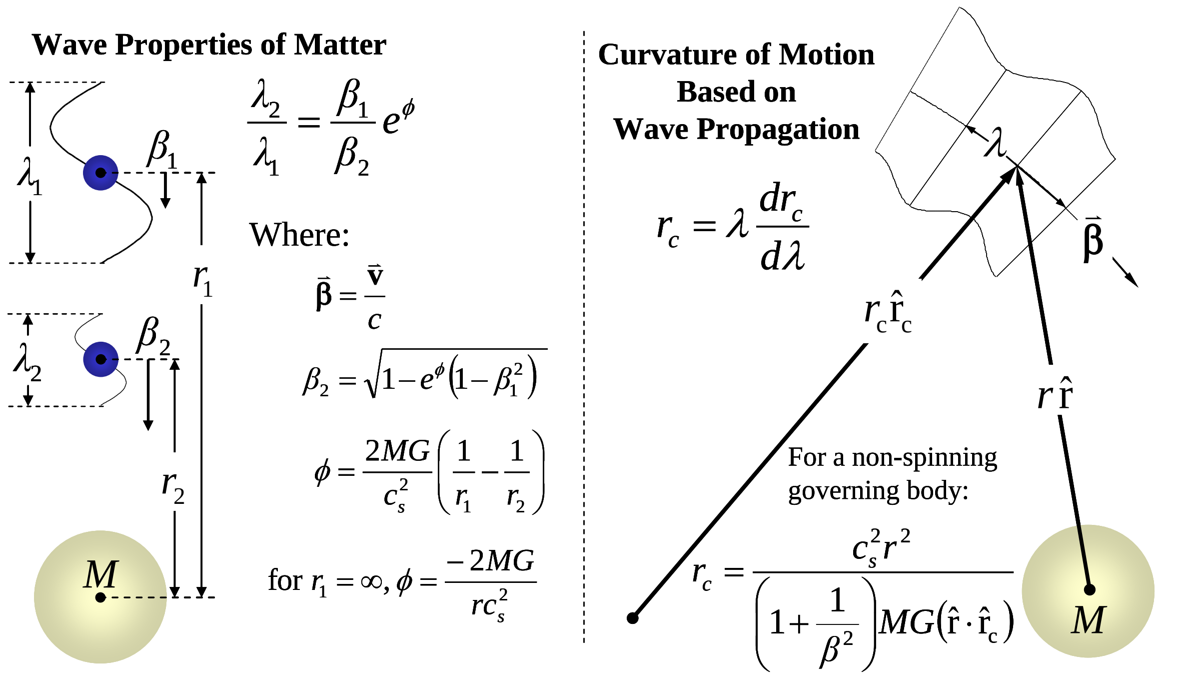


Figure 5 The trajectory of a freely falling body in a gravitational field is independent of its internal structure and composition.

As outlined in Figure 5, we can calculate the path of matter in any form as it passes through a gravitational field with equation (10) which is based on wave-particle duality. Note, in this equation λ is a function of *r*.

$$r_c = \lambda \frac{dr_c}{d\lambda} \tag{10}$$

For a single non-spinning governing body this reduces to equation (11).

$$r_c = \frac{c_s^2 r^2}{\left(1 + \frac{1}{\beta^2}\right) MG(\hat{r} \cdot \hat{r}_c)} \tag{11}$$

By studying equation (11), we observe that the trajectory of a freely falling body in a gravitational field is independent of its internal structure and composition. As a result, we can use the same equation to describe the motion of a wave of light or a planet near a governing body.

These equations were programmed into an Excel spread-sheet for investigating the motion of light in a strong gravitational environment. Figure 6 presents the results of a numerical analysis conducted with this spreadsheet to determine the minimum emission angle, relative to radial, that is required for light to escape from a gravitational field. The emissivity of a quasar is a function of this angle as defined by equation (12) and as illustrated in Figure 6. Equation (12) is simply the geometric ratio of the area of a spherical cap defined by α to that of a hemisphere.

$$\varepsilon = \frac{A_{\text{spherical cap}}}{A_{\text{hemisphere}}} = 1 - \cos\alpha \tag{12}$$

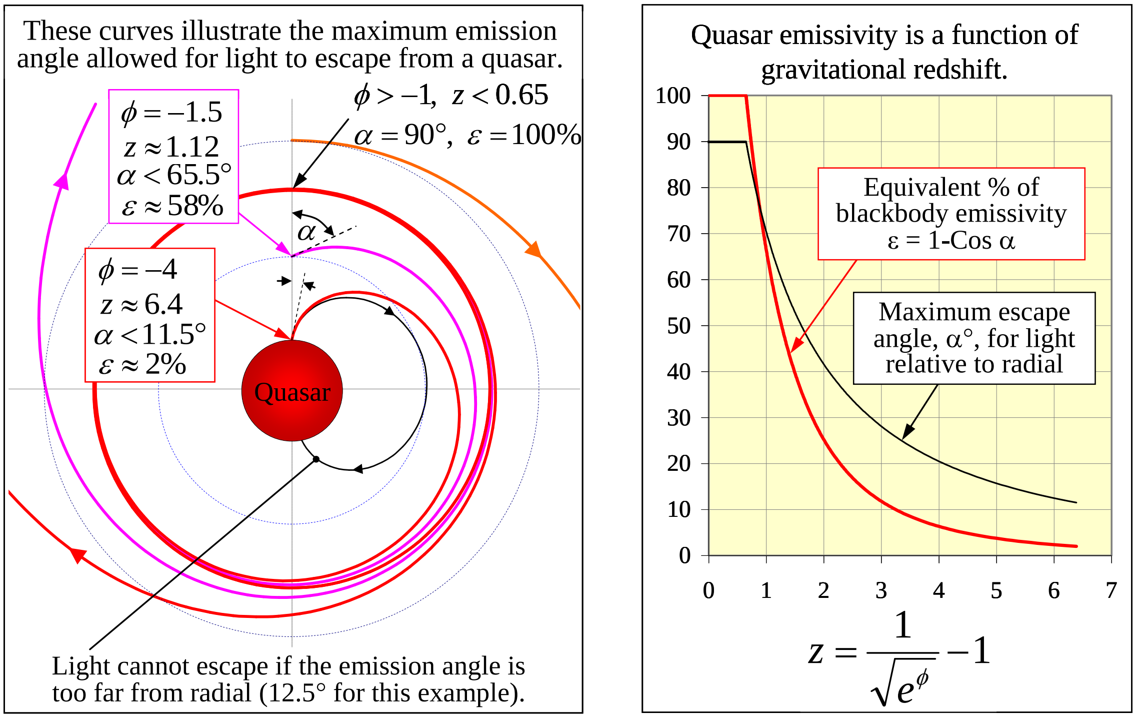


Figure 6 Quasar emissivity is a function of gravitational redshift.

This demonstrates that TMG provides a very simple way for us to calculate the emissivity of a quasar with equations based on the wave-particle duality of matter. As illustrated in Figure 6, the emissivity of a quasar is equivalent to that of a black body for ϕ > -1. However, for values of ϕ < -1, the emissivity of a quasar drops off rapidly.

It is interesting to note that general relativity predicts a singularly or black hole at ϕ = -1. However, by applying the equations of TMG we observe that instead of finding a singularity, we should expect to find objects such as quasars that appear highly redshifted. We should also expect these objects to be harder to detect because their emissivity drops off rapidly with increasing gravitational redshift as illustrated in Figure 6. This is precisely what we observe in the population distribution recorded in the NASA/IPAC Extragalactic Database.

3.4 Radius versus gravitational redshift

From the TMG derivation, we can calculate the influence of the properties of space on the density of free rest matter such as an individual electron, proton, or atom with equation (13).

$$\rho = \rho_\infty \frac{c_\infty}{c} \tag{13}$$

If we combine this with equation (6) we obtain:

$$\rho = \rho_\infty e^{-\phi} \tag{14}$$

This represents the increase in density of a single electron, proton, or atom if there are no other influences involved. However, for a governing body, much of the matter is compressed. For example, the density of a gas increases with pressure. Theoretical calculations in the published literature indicate that massive stars under the right conditions can even be compressed into neutrons to form a neutron star. We can account for this by introducing a compression factor defined as:

$$\gamma = \frac{\rho_{average}}{\rho_{\infty} e^{-\phi}} \tag{15}$$

Where:

ρ_{∞} = The maximum possible density of rest matter infinitely far away from the governing body.

The mass of a spherical body can be approximated as:

$$M = \rho_{average} V = \rho_{average} \frac{4}{3} \pi r^3 \tag{16}$$

Substitute equation (16) into equation (5)

$$-\phi = \frac{2G\rho_{average} \frac{4}{3} \pi r^3}{r c_s^2}$$

Rearrange the terms:

$$r = \sqrt{\frac{-3\phi c_s^2}{8G\rho_{average} \pi}} \tag{17}$$

Substitute equation (15) into equation (17)

$$r = \sqrt{\frac{-3\phi c_s^2}{8\pi G \gamma \rho_{\infty} e^{-\phi}}} \tag{18}$$

Equations (1) and (18) make it possible for us to plot the radius of a very large governing body as a function of ϕ as illustrated in Figure 7 for a constant compressibility factor (γ) of one. It is interesting to note that for a γ of one, the maximum radius of a governing body will correspond to a ϕ of -1 and a gravitational redshift of about 0.65. However, if the compressibility factor is not constant then the maximum radius will occur at a different redshift.

It is important to recognize that this method does not restrict a quasar to any given size or mass. In fact, based on this method a quasar of any given mass is possible ranging from the size of an atom to an infinite value. Therefore, a quasar formed from more than a trillion solar masses is possible. Furthermore, its redshift will be a function of its density.

3.5 Temperature versus redshift

For this work let us assume a quasar's radiant power is gravitational in nature. Let us also assume that the surface temperature is a function of the kinetic to total energy ratio required for an object to escape from its gravitational influence. We can then calculate the surface temperature of a quasar as follows:

According to the kinetic theory of gasses, the temperature of a gas is proportional to its average kinetic energy, K, as defined by equation (19) in which k represents Boltzmann's constant.

$$T = K \frac{2}{3k} \tag{19}$$

From TMG, kinetic energy is defined as:

$$K = mc_s^2\left(1-\sqrt{1-\beta^2}\right) \tag{20}$$

At very low velocities this approaches the commonly used approximation given by equation (21).

$$K = \frac{mv^2}{2};\ \text{for } v << c \tag{21}$$

Substitute equation (20) into (19)

$$\frac{T}{T_{\max}} = \frac{K}{K_{\max}} = \left(1-\sqrt{1-\beta^2}\right) \tag{22}$$

Note: The maximum kinetic energy represents the limit in which a gravitational field converts all of the matter falling onto a governing body into light. Or in other words, it is the point at which $\beta = 1$, therefore, the escape velocity is equal to c.

Substitute equation (9) into (22), with $\beta_1 = 0$, to calculate the temperature associated with the escape energy:

$$\frac{T}{T_{\max}} = 1-\sqrt{e^{\phi}} \tag{23}$$

This provides a simple way to estimate the surface temperature of a quasar based on the assumption that it is proportional to the escape kinetic energy. This result (see Figure 7) is only a function of a ϕ and therefore independent of the density of the quasar.

3.6 Quasar Luminosity

By combining the equations we have developed we can calculate the luminosity of a quasar as a function of gravitational redshift as illustrated in Figure 7 and Figure 8. In doing so, we use the standard method for calculating blackbody radiation as defined by equation (24) where σ is the Stefan-Boltzmann constant for black body radiation.

$$L = 4\pi r^2 \sigma \varepsilon T^4 \tag{24}$$

It follows that:

$$\frac{L}{L_{\max}} = \varepsilon\left(\frac{r}{r_{\max}}\right)^2\left(\frac{T}{\mathrm{T}_{\max}}\right)^4 \tag{25}$$

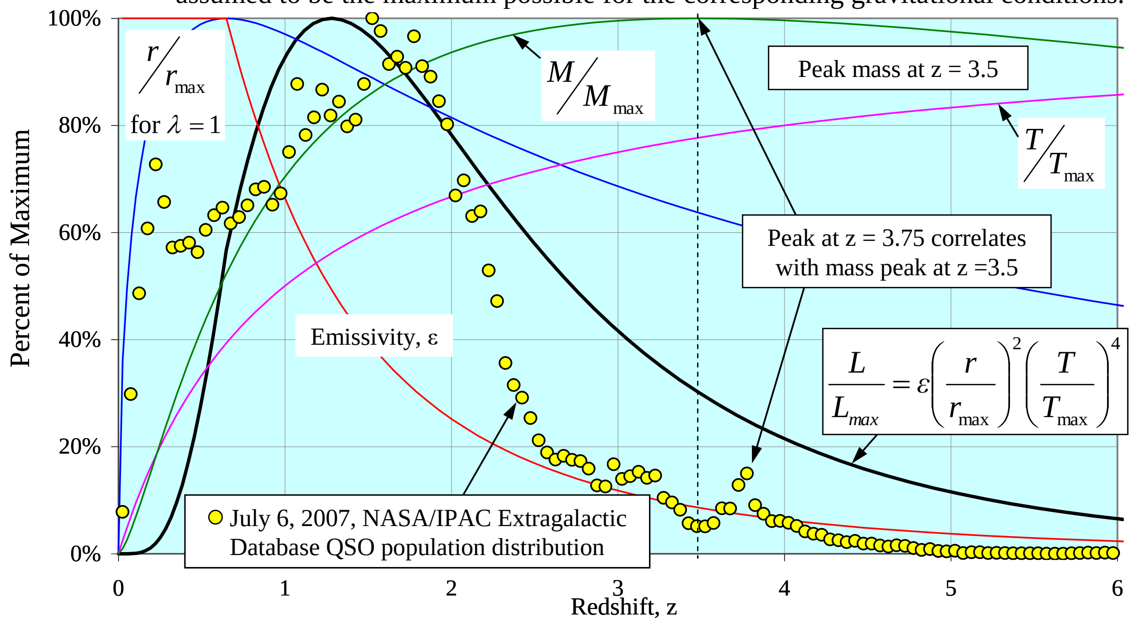
Where:

ε is based on the analysis presented in Figure 6.
r is calculated with equation (18).
T is calculated with equation (23).

The results presented in Figure 7 illustrate that the method we have used to calculate luminosity for quasars of a constant structure such as a neutron star, correlates very well with the overall trend in the observed population distribution data. The term "constant structure" means that γ as defined in equation (15) is constant and independent of redshift. Table 1 records how and when the data was retrieved from the NASA/IPAC Extragalactic Database. The results presented in Figure 7 represent 115 590 objects identified as QSO and QSO Groups plotted with a 0.05 redshift bin size (QSO means Quasi-Stellar Object, a quasar). The general trend in the predicted luminosity is reflected very well in the data. A reasonable variation from one or more of the assumptions we have used (for example, γ is probably not constant) is all that is required to bring the calculation and data into perfect agreement.

As illustrated in Figure 7, the data peak at a z = 3.75 is associated with the maximum predicted mass at a z = 3.5. This indicates that for a gravitational redshift greater than 3.5, a quasar is capable of converting matter directly into energy. In other words, it naturally wants to occupy a smaller space. However, it can't do so unless it loses mass. If the redshift of a quasar approachs a value of approximately 3.5 it should produce an initial flair up in luminosity (this could produce a gamma ray burst). In time, a state of equilibrium should result at which point a quasar will convert its mass to energy at the same rate at which it can be radiated into space. Therefore, we refer to this process as radiation limited gravitational collapse. This will cause a further increase in redshift. A polar jet which is a common feature of quasars could speed up this process. In the end, given enough time, a quasar will eventually "evaporate" through this process until it disappears. It is interesting to note that under these conditions, quasars do not need any other power source to explain their luminosity. This observation is in agreement with the Chandra X-ray Wide-field Panorama.

- This chart presents results for $\gamma = 1$. Therefore, at any given redshift, the density is assumed to be the maximum possible for the corresponding gravitational conditions.



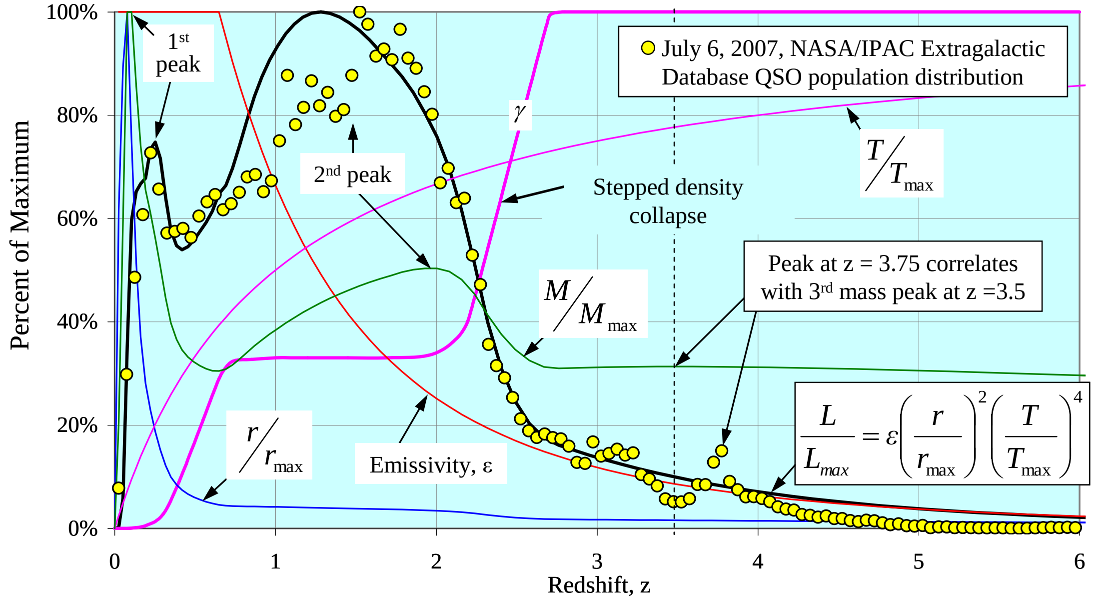
The data peak at z = 3.75 correlates with the maximum quasar mass at z = 3.5, indicating it may be caused by a radiation limited gravitational collapse.

Figure 7 Quasar emissivity is a function of gravitational redshift for a constant γ.

The ability of quasars to ignite in a form of radiation limited gravitational collapse may also help to solve the mystery as to why there is so much hydrogen in the universe. It appears that very high redshift quasars have the ability to break down the atomic structure of matter such as helium, oxygen, iron, gold, or uranium, into neutrons, protons, and electrons. The protons and electrons could then be ejected back into space through polar jets where they would recombine into hydrogen. In other words, quasars appear to have the ability to recycle matter back into the basic building blocks of stars such as our Sun.

Figure 8 illustrates one method for bringing the calculated luminosity into better agreement with the data by assuming that quasars at different redshifts can have a different structure. If we assume a stepped density collapse we are able to achieve a remarkable level of agreement as illustrated in Figure 8.

• Peaks in the quasar population distribution appear to correlate with peaks in the calculated mass.



• 1st and 2nd data peaks correlate with the stepped density collapse associated with a change in γ.

• The mass peak at z = 3.5 is not caused by a change in γ. This indicates that the data peak at z = 3.75 which follows the mass peak, may be caused by a radiation limited gravitational collapse.

Figure 8 Quasar luminosity for a stepped gravitational collapse - see Figure 9 for luminosity and γ curves only

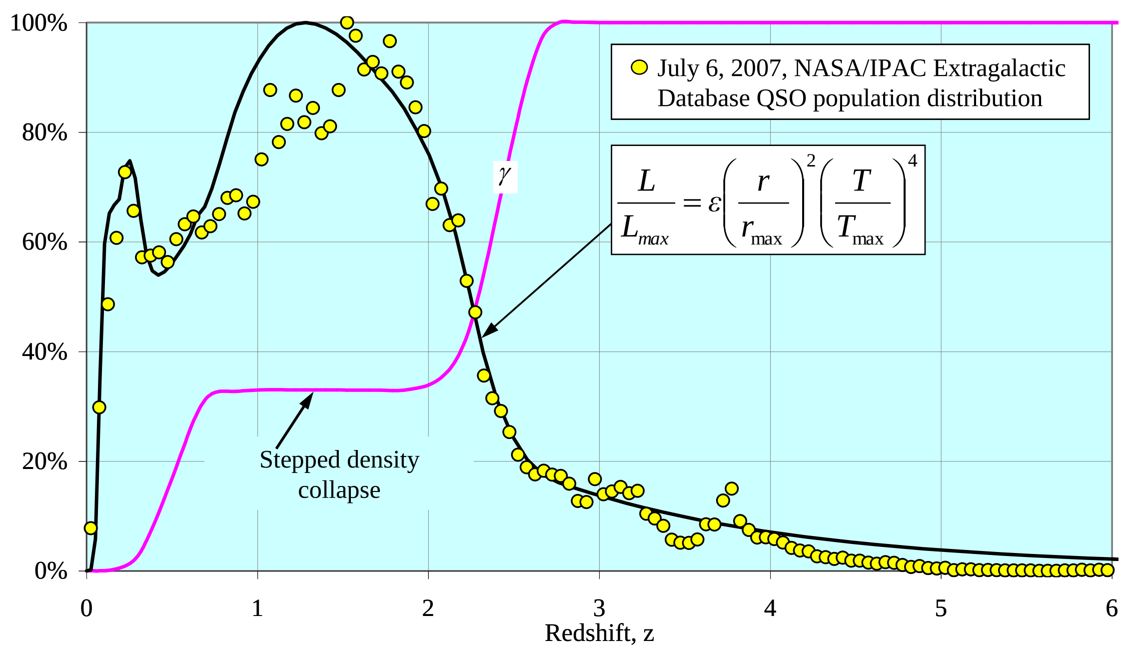


Figure 9 Quasar luminosity based on TMG provides a good match to the data

Figure 8 also illustrates how a stepped density collapse in the data could provide a much better data match. It is interesting to observe that this type of influence lines up three significant peaks in the population distribution with the calculated luminosity and again with the peak mass at a redshift of 3.75. However, other influences should also be investigated such as:

- The variation in the true population as a function of gravitational redshift.
- The variation in quasar temperature as a function of gravitational collapse.
- The influence of accretion disks that may be more prevalent under certain conditions, etc.

In summary, the remarkable correlation between the calculate luminosity and data presented in Figure 8 illustrates that this method provides a very reasonably model of quasars.

4. Conclusion

Based on the published literature, the current popular model does not accurately describe that nature of quasars. Furthermore, due to serious limitations, we must look for an alternative to general relativity.

The method documented in the book *Time, Matter, and Gravity*, based on the wave-particle duality of matter, provides a very reasonable quasar model that is supported by the data. Based on this method we are able arrive at the following conclusions.

1. Based on the 2007 Chandra X-ray wide-field panorama data, many quasars do not have an accretion disk. **This invalidates the current popular black hole quasar model.**

2. The TMG method for calculating quasar luminosity is supported by the observed population distribution recorded in the NASA/IPAC Extragalactic Database.

3. High redshift quasars are difficult to detect because they tend to be very compact and the gravitational bending of light greatly reduces their emissivity.

4. TMG indicates gravitational conditions may become critical at a redshift of 3.5, causing a quasar to ignite with the ability to convert mass directly into energy. A state of equilibrium is predicted because a quasar can only convert mass to energy at the same rate at which it can be radiated into space. The associated luminosity increase provides an explanation for the peak, at a redshift of 3.75, in the observed population distribution.

5. The results of this study indicate quasars may be capable of recycling matter back into hydrogen and sending it out into space through polar jets.

6. The success of the TMG natural exponential solution indicates that the general relativity concept of a black hole is an illusion caused by a 1^{st} order approximation of nature.

7. The TMG method provides a good model of natural behavior under both weak and strong gravitational conditions.

The TMG approach used for this research has not yet been fully extended to a dynamic gravitational environment. However, the simplicity of the approach coupled with the remarkable success in modeling static gravitational environments including that of a quasar is very encouraging. Hopefully future efforts to include dynamic influences will meet with similar success. An added benefit is that unlike general relativity, the wave-particle duality method of TMG merges seamlessly with wave mechanics.

Table 1 This presents a record of how and when the quasar population distribution data was retrieved from the NASA/IPAC Extragalactic Database. The sample contains 115 590 objects identified as QSO and QSO Groups. A list of the individual objects is not included. However, this information, as retrieved from the web, has been stored and is available upon request from the Author if needed for verification.

NASA/IPAC EXTRAGALACTIC DATABASE

Date and Time of the Query: 2007-07-06 T11:54:17 PDT

Help | Comment | NED Home

You have selected the following parameters to search on.

RA: Unconstrained
DEC: Unconstrained
GLON: Unconstrained
GLAT: Unconstrained
Redshift: Between 0.000000 and 0.250000
Flux density: Unconstrained
Flux ratio: Unconstrained
Include ANY Object Type: QSO QSOGroups
Exclude ANY Object Type:

NED results for your specified parameters:

6686 object(s) found in NED.
retrieving them may take a while ...

Using the same search parameters, the following information was also retrieved.

Date and Time of the Query: 2007-07-06 T12:02:15 PDT 9000 object(s) found in NED.	Redshift: Between 0.250001 and 0.500000
Date and Time of the Query: 2007-07-06 T12:07:48 PDT 9494 object(s) found in NED.	Redshift: Between 0.500001 and 0.750000
Date and Time of the Query: 2007-07-06 T12:10:46 PDT 10169 object(s) found in NED.	Redshift: Between 0.750001 and 1.000000
Date and Time of the Query: 2007-07-06 T12:12:52 PDT 12453 object(s) found in NED.	Redshift: Between 1.000001 and 1.250000
Date and Time of the Query: 2007-07-06 T12:15:04 PDT 12628 object(s) found in NED.	Redshift: Between 1.250001 and 1.500000
Date and Time of the Query: 2007-07-06 T12:17:24 PDT 14386 object(s) found in NED.	Redshift: Between 1.500001 and 1.750000
Date and Time of the Query: 2007-07-06 T12:19:37 PDT 13439 object(s) found in NED.	Redshift: Between 1.750001 and 2.000000
Date and Time of the Query: 2007-07-06 T12:22:00 PDT 9634 object(s) found in NED.	Redshift: Between 2.000001 and 2.250000
Date and Time of the Query: 2007-07-06 T12:25:11 PDT 10271 object(s) found in NED.	Redshift: Between 2.250001 and 3.000000
Date and Time of the Query: 2007-07-06 T12:27:10 PDT 7430 object(s) found in NED.	Redshift: Between 3.000001 and 100.000000

5. References

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Reference 2 In Quest of the Universe/ Karl F. Kuhn © 1991 Page 501

Reference 3 Astronomy Today / Eric Chaisson, Steve McMilan. —5th ed. © 2005 Page 589.

Reference 4 B. Mashhoon, Phys. Lett. A 122 (1986) 6, 7

Reference 5 *Time, Matter, and Gravity* © 2004 by Morris G. Anderson. An electronic copy can be downloaded: https://www.rxiv.org/pdf/2102.0123v1.pdf

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