Pleiades and Orion: bound, unbound, or … ?

John Hartnett

The beautiful Pleiades cluster and dominant Orion constellation are two of the most well-recognized groupings of stars in the night sky. They are mentioned in Job 38:31, where God poses a series of rhetorical questions to Job about the majesty of His creation, in contrast to Job's abilities. Some creationists have suggested that astrophysical information was recorded in this passage, verifying the Bible's claim to truth. However, recent pictures by both orbiting and land-based space observatories contradict the interpretation that the (astrophysically) bound and unbound conditions of these star groupings are foretold in Scripture. Read in context, there is no valid reason for extrapolating this passage to imply anything other than a declaration of God's power in His majestic creation.

Pleiades and Orion are easily recognized groupings of stars seen in the night sky. Pleiades is well known as the Seven Sisters, and Orion as the Great Hunter. The constellation of Orion contains a large cloud of gas and dust, which is centred around the Orion Nebula located at the middle star of the Hunter's Sword. There has been much confusion over the years about a Bible verse describing these two constellations.

In Job 38:31 (NIV) we read: 'Can you bind the beautiful Pleiades? Can you loose the cords of Orion?' The NKJV is slightly different: 'Can you bind the cluster of the Pleiades, Or loose the belt of Orion?'

It is evident that the Bible translators were not sure of the exact meaning here. The Hebrew used for 'belt' tkvwm (*môsh^{e}koṯ*) is in the plural form. It is more correctly translated 'cords' as in the NIV, or 'bands' as in the KJV, which reads, 'Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion?'

The Hebrew word for 'influences' tndem (*ma'adannoṯ*) seems to mean bonds or bands. It seems that God is saying to Job (my phrasing): 'Can you bind together the stars in Pleiades or break the bonds between the stars in Orion?

Chapters 38 and 39 are God's stormy response to Job's questioning about justice regarding his traumatic circumstances in the previous chapters. God's answer includes a number of statements about God's creation and rhetorical questions (including the questions about Pleiades and Orion), which are clearly to be answered *no*. Job cannot do the things God has done, God is truly sovereign, and it is not Job's place to question Him.

Some have said that the meaning of Job 38:31 is that God is asking Job if he could have (gravitationally) bound together the stars in the cluster in Pleiades or broken the gravitational bonds holding the stars together in a cluster in Orion. Until recently, it was thought by some that Pleiades was a bound cluster and that parts of Orion was an unbound cluster. So this argument has been commonly used to support divine inspiration. (How could the ancient writers have known the 'gravitational facts' concerning these two objects prior to the advent of modern astronomy?) However, more recent astronomical investigations have shown that the 'gravitational binding' situation for these two star formations is the *exact opposite* of what was once believed.

As we will see, it is unwise to read more into biblical texts than the context warrants.

Seven stars

What did, or could, the ancient writers have known of these clusters of stars? The Hebrew word hmyk (*kîmâh*) so rendered *Pleiades* occurs also in Amos 5:8 as 'the seven stars', in the KJV, which says, 'Seek him that maketh the seven stars and Orion.'

Clearly the Bible says God is the Creator of these stars both in Pleiades and in Orion. It also seems that the ancients viewed Pleiades as a group of seven stars. It is visible to the naked eye as seven bright, blue-white stars, also called the *Seven Sisters* (see figure 1).

Pleiades was designated as M45 by Charles Messier in

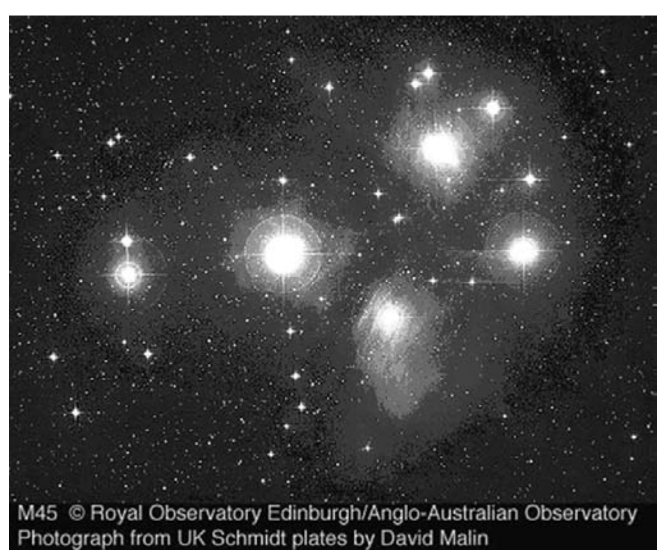


Figure. 1. *Pleiades, a photograph taken by David Malin with the UK Schmidt Telescope. Note that the apparent size of the stars is an artefact of the telescope. In reality, the stars are so distant that they are just points in size.*

Figure 2. *Image of Pleiades, M45, taken with the 0.9-m telescope of Kitt Peak National Observatory, in 1975. At Pleiades' distance of about 400 light-years, the image field of view corresponds to a linear diameter of 20 light-years.*

his first list of nebulae and star clusters, published in 1771. On a clear night the Pleiades can be easily seen about 10 degrees north-west of the bright red-giant star Aldebaran. This group of stars, which numbers many more than is visible to the naked eye, is approximately 380 light-years from Earth.[1] They are mentioned three times in the Bible, by Hesiod between 1000 and 700 BC and by Homer in his *Odyssey*. Quoting from a web source:

> 'The Pleiades are among those objects which are known since the earliest times. At least 6 member stars are visible to the naked eye, while under moderate conditions this number increases to 9, and under clear dark skies jumps up to more than a dozen (Vehrenberg, in his *Atlas of Deep Sky Splendors*, mentions that in 1579, well before the invention of the telescope, astronomer Moestlin has correctly drawn 11 Pleiades stars, while Kepler quotes observations of up to 14. Burnham points out that the name 'Pleiades' may be derived from either the Greek word for 'to sail', or the word 'pleios' meaning "full" or "many".'[2]

About 1846, the German astronomer Mädler noticed that the stars of Pleiades had no measurable proper motion relative to each other or with the star Alcyone in the centre of the group (i.e. they are all moving in the same direction). Groups of stars that move together are called a cluster. Modern astronomy has shown that the constituent stars of Pleiades are expected to dissociate within the next 250 million years,[3] and hence Pleiades is an open or unbound cluster. That is, the motions and velocities of its constituent objects are such that the gravitational forces between them are not sufficient to hold it together (as a recognizable cluster) over the longer term.

A 'bound' cluster, by contrast, can be shown to still be a recognizable grouping even if its motions are projected forward by a billion years or so. Throughout this paper I use the words 'bound' and 'unbound' defined as follows. A bound cluster is in virial equilibrium[4] and will not dissipate or break apart given any amount of time. An unbound cluster is the opposite. The mutual gravitational forces between the constituents are insufficient, over time, to prevent the cluster's dissipation due to the relative motions of its members.

Modern astronomy has revealed that more than 500 mostly faint stars belong to the Pleiades star cluster, spread over a region about four times the diameter of the moon (as seen from Earth). The density of the cluster is low, compared to other galactic clusters, and longer-exposure photographs show the Pleiades to be embedded in nebulous material (figures 1 and 2). Pleiades is a large but expanding, or unbound, cluster of stars that are all just passing the same region of space at the same time with the same motion.

Figure 3 shows an image[5] of the Pleiades cluster taken by the Rosat X-ray telescope from space. Clearly there are many more stars than the optical images show. X-ray images reveal the true extent of the cluster.

Orion's Belt

Many people recognize the three stars known as Orion's Belt, which are pictured in fig. 4 in the centre of the Orion constellation. The NKJV of Job 38:31 apparently refers to these three stars. It uses the word 'belt' but is that possibly the result of a reliance on man's knowledge to translate the text?

The Orion Nebula, also named M42, is an emission

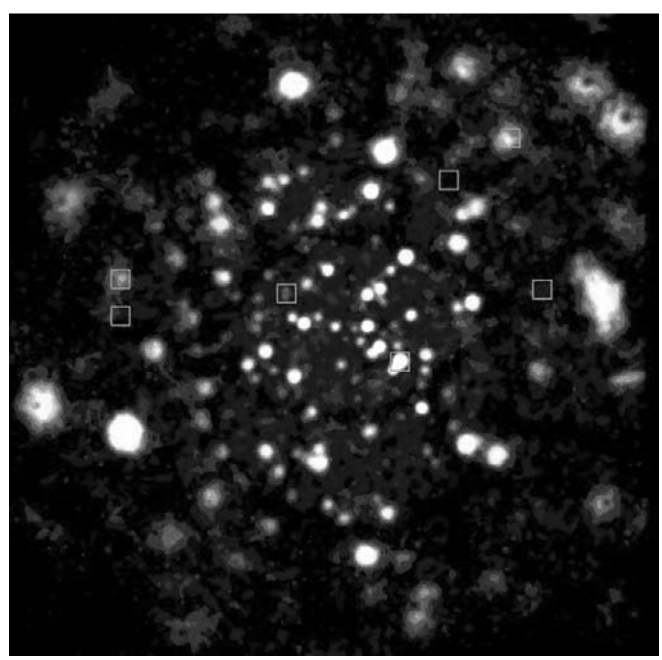


Figure 3. *Rosat image of Pleiades in X-rays. The optically brightest stars are indicated by the squares. The brightest X-ray stars are those with the hottest atmospheres. Credit: Thomas Preibisch. <www.xray.mpe.mpg.de/>, <www.mpe.mpg.de/>.*

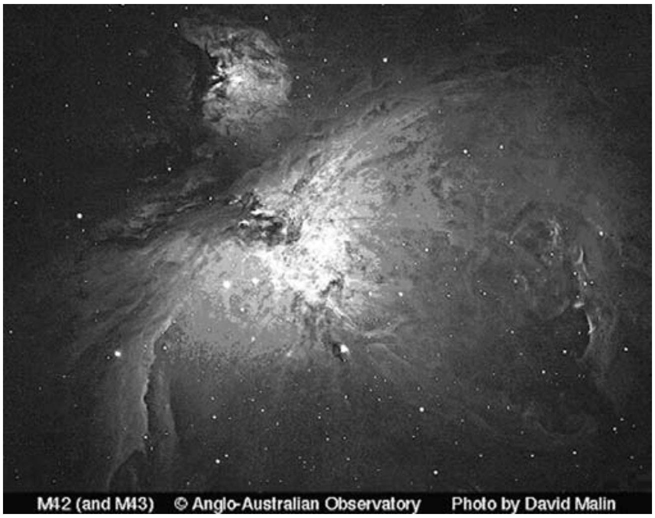


Figure 4. *The Orion Nebula (M42) centred around the middle 'star' (Theta Orionis) of Orion's Sword. The smaller nebula at the top (M43) is considered to be part of the Orion Nebula separated by darker material. (Photo by David Malin).*

and reflection nebula. Nicholas-Claude Fabri de Peiresc was likely the first to identify the Nebula, in 1610. The Jesuit astronomer Johann Baptist Cysatus of Lucerne also independently identified it in 1611. Located at a distance of around 1,300 light-years from Earth, the Orion Nebula is the brightest diffuse nebula in the sky and visible to the naked eye under good conditions.[6] It is very easy to find as it surrounds the Theta Orionis multiple star in the middle of the Sword of Orion.

The Orion Nebula is the main part of a much larger cloud of gas and dust extending across the night sky over 10 degrees, taking in over half the constellation of Orion (figure 6). The cloud's linear extent is over several hundred light-years. It contains the Orion Nebula near its centre and other famous objects such as Barnard's Loop, the Horsehead Nebula and the reflection nebula M78. The Orion Nebula itself is an impressive sight both in visible and infrared light. It covers an area of the sky four times the size of the full Moon and has a linear diameter of about 30 light-years. The initial identifications of the Orion Nebula apparently 'got lost' for some time, so that eventually Christian Huygens was credited for his independent rediscovery in 1656, e.g. by Charles Messier when he added it to his catalogue on 4 March, 1769.[5]

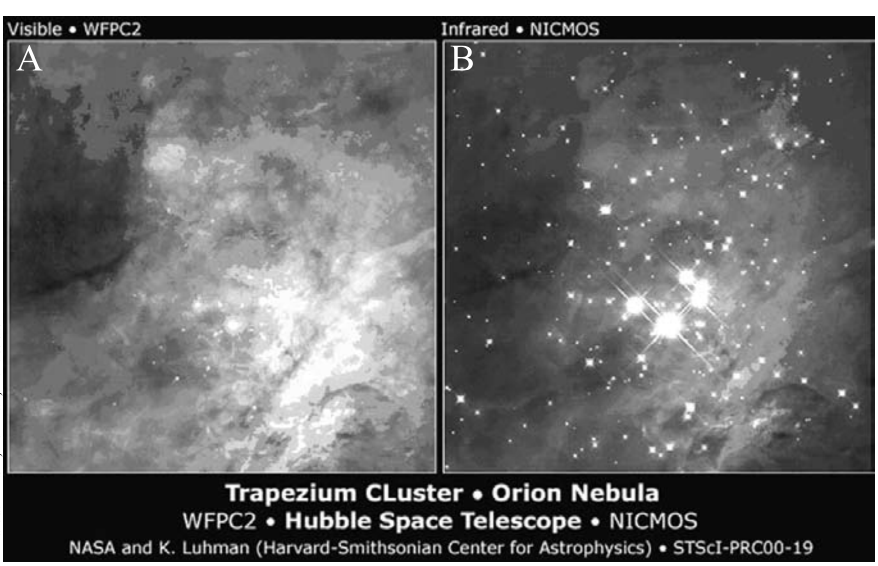
Trapezium Cluster

If we look more closely into the core region of the Orion Nebula we may see a small group of stars exciting most of the visible nebulosity. The set of four optically visible stars at the core of the nebula forms the Trapezium. The stars in this region are known to be luminous X-ray sources.[7] A few stars can be made out in the visible spectrum (figure 5–A). But if we look at the image taken with infrared light (figure 5–B), which is able to penetrate the dusty regions, we see a beautiful cluster of stars that was hidden from view. The Trapezium lies at the front surface of a massive, dusty molecular cloud. The Trapezium stars, labelled 'A', 'B' and 'C', were first described by Christian Huygens in 1656 when he independently rediscovered the Orion Nebula. The fourth, or 'D', was first found by Abbé Jean Picard in 1673, and later independently by Huygens in 1684.

Near-infrared photons escape the dusty Orion molecular cloud much more easily than optical photons, enabling detection of hundreds of stars embedded within the cloud core that lies just behind the Trapezium. Since the opacity of a typical molecular cloud to 1 keV photons is approximately the same as the dust opacity of such a cloud at 2 microns, it is assumed that the cloud is dominated by dust. In 1998, it was claimed that NASA's Hubble Space Telescope, while probing deep within the Trapezium cloud, uncovered a swarm of brown dwarf stars. The HST's near-infrared camera revealed about 50 of these objects throughout the Orion Nebula's Trapezium Cluster.[8]

It was further claimed that it is a region of star birth, a star nursery:

> '… 300 fledgling stars and brown dwarfs surround the brightest, most massive stars in Hubble's view of the Trapezium Cluster's central region. All of the celestial objects in the Trapezium were born together in this hotbed of star formation. … The Hubble telescope's near-infrared camera, the Near Infrared Camera and Multi-Object Spectrometer, penetrated those clouds to capture a view of those objects. The brown



Visible light: NASA, O'Dell, C.R. and Wong, S.K.
Infrared: NASA, Luhman, K.L. *et al.*

Figure 5. *The central region of the Orion Nebula where the Trapezium Cluster is found. The left image is in visible light and the right image is in infrared.*

dwarfs are the faintest objects in the image. Surveying the cluster's central region, the Hubble telescope spied brown dwarfs with masses equalling 10 to 80 Jupiters.'[5]

In fact, no star formation was observed. Such claims are based on computer simulations. What was observed were very-low-mass, dim stars, which were emitting a lot of infrared as well as X-rays. There are seemingly insurmountable problems with models of stellar formation, which counter these claims, but that is beyond the scope of this article.

Figure 7 shows an X-ray image of about a thousand X-ray-emitting stars in the Orion Nebula star cluster (ONC), taken by the Chandra X-Ray Observatory.[9] The X-rays are produced in the very-high-temperature atmospheres of these stars. These are the stars illuminating all the dust in the Orion Nebula. This image (figure 7) corresponds to a region of about 10 light-years across. The bright stars in the centre are part of the Trapezium. This image clearly reveals a very tightly bound cluster. The Orion Trapezium Cluster is a subgroup of stars at the core of the ONC confined within a radius of about 1.5 light-years. It has been argued by some that the infrared-imaged cluster (figure 5-B) is another cluster behind the Trapezium Cluster and that the ONC is fostering a double cluster system.

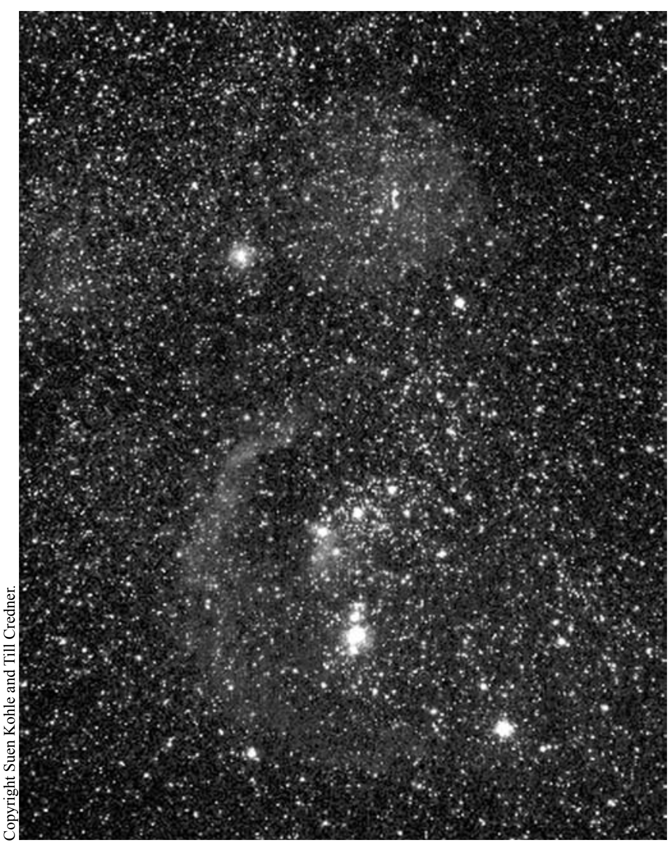


Figure 6. *The constellation of Orion. M42 and M43 (in the the middle of Orion's Sword hanging from his belt) are part of a larger cloud that includes the horsehead nebula (located adjacent to the left-most star of Orion's belt) and Barnard's loop (the cresent shaped cloud on the left).*

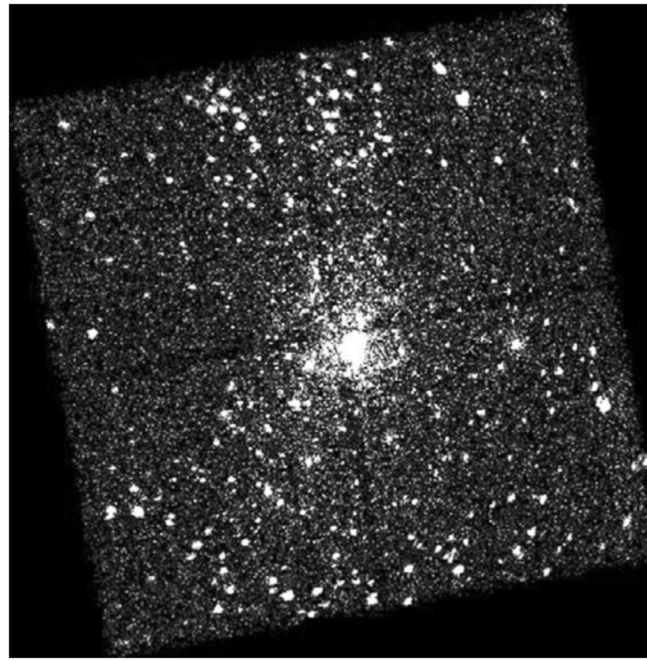


Photo by NASA/PSU.

Figure 7. *Chandra X-Ray Observatory image of M42. The dark vertical and horizontal lines, and the streaks from the brightest stars, are instrument effects.*

The naturalistic formation of bound star clusters is a major unsolved problem in observational and theoretical astrophysics. Significant resources, both theoretical and observational, are being directed at solving this problem. But serious technical difficulties remain. Kroupa[10] has modelled birth scenarios for some young, compact, binary-rich clusters and has found possible birth models leading to the Orion Nebula Cluster (ONC), of which the Trapezium Cluster is the core. He found a narrow range of solutions, which allow the ONC to be in virial equilibrium, expanding or contracting. This means that the ONC is a gravitational bound cluster, even though it may be expanding or contracting. Also for a group of stars to be located in a region of space with only a radius of 1.5 light-years, it would seem they are gravitationally bound.

The HST and Chandra have both taken very clear images of the four bright primary stars that form the Trapezium (and others that are not so bright). They can be seen in figure 8, in visible light overlaid with X-ray images. The Lord has created but also hid from view, until now, a tightly bound cluster of stars in Orion behind the Trapezium.

Conclusion

What was originally thought to be bound is unbound and what was thought to be unbound is bound (given current astrophysical definitions). In this paper 'bound' describes a gravitationally stable state and 'unbound' describes a collection of stars that are mutually passing the same point in space but are not gravitationally tied together. What can be made of all this? Creationists need to be careful not to read into the text more than is appropriate. In context, God's

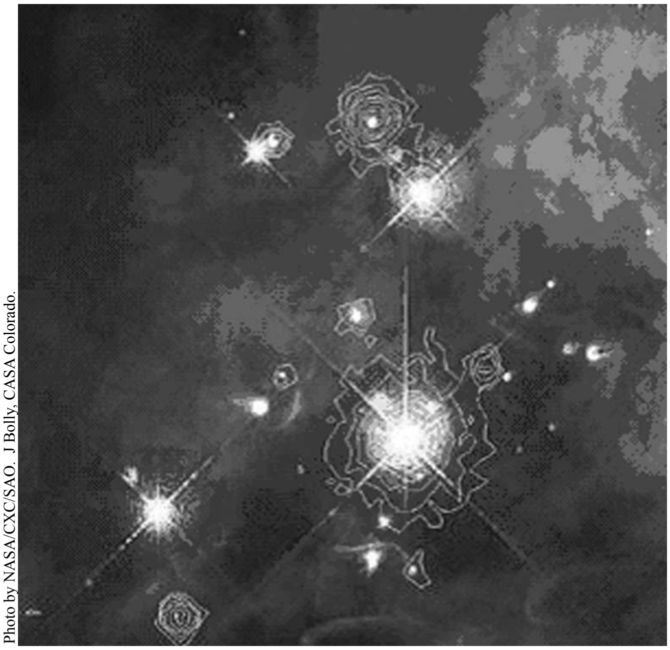


Photo by NASA/CXC/SAO. J Bolly, CASA Colorado.

Figure 8. *Overlay of optical (HST) and X-ray (Chandra) images of the Trapezium.*

questioning of Job is rhetorical, aimed at clearing up any question of God's sovereignty. This passage is not teaching about cosmology—in contrast to Gen. 1:14–18, where God is clearly stating when He made the sun, moon and stars.

The text in Job 38:31 and 32 describes real astronomical bodies in poetical language. Making cosmological assertions about such poetical texts (as opposed to the clearly historical narrative of Genesis 1) is not wise. In the past, some have used this passage in Job to claim biblical accuracy in relation to the universe. As pointed out earlier, it was argued that God was asking Job if he can do the same as God, while now we could turn the argument around and suggest that God is asking Job if he can undo what God has done (though this would not be consistent with the rhetorical negative answers of the other questions).

Such rubbery interpretations should be a warning to us of poor exegesis. There is no reason to think that the Job passage has anything to do with the minutiae of the gravitational forces and motions within each cluster. The passage is perfectly understandable from Job's perspective, as a reflection on God's sovereignty in establishing and controlling the positions and motions of the heavenly bodies, period.

The verse in Job following the one about Pleiades and Orion states: 'Can you bring forth the constellations in their seasons or lead out the Bear with its cubs?' If we insist that the Pleiades/Orion passage is about bound and unbound clusters, what is to be made of leading out the Bear (Arcturus [KJV])? Again this makes sense if one realizes it is being used to make a powerful point about God's sovereignty—not teaching specifics about astrophysics. Truly 'the heavens declare the Glory of God' (Psalm 19:1); however, we must be careful not to 'go beyond what is written' (1 Corinthians 4:6).

References

1. This was recently determined by direct parallax measurement by ESA's astrometric satellite Hipparcos.
2. <http://www.seds.org/messier/m/m045.html>, 15 March 2004.
3. Meynet, G., Mermilliod, J.-C. and Maeder, A., New dating of galactic open clusters, *Astron. Astrophys. Suppl. Ser.* **98**, pp. 477–504, 1993.
4. A state where a cluster is in a dynamic equilibrium. The virial theorem states that, for a stable, self-gravitating distribution of objects (stars, galaxies, etc.), the time-averaged total kinetic energy of the objects is equal to minus half the time-averaged total gravitational potential energy. Energy may shift between gravitational potential energy and kinetic energy for the individual objects but the time-averaged values of the total potential and total kinetic energies of the system remain constant. The constituents will never break up unless acted upon my outside forces. The positions and velocities of the constituents are bounded for all time.
5. <www.seds.org/messier/more/m045_more.html>.
6. <www.seds.org/messier/m/m042.html>.
7. <http://space.mit.edu/ASC/science/orion/orion.html>.
8. <www.seds.org/messier/more/m042_h5.html>.
9. <www.seds.org/messier/more/m042_cxo.html>.
10. Kroupa, P., Constraints on stellar-dynamical models of the Orion Nebula Cluster, *New Astron.* **4**:615–624, 2000.

John G. Hartnett received both his B.Sc. (hons) (1973) and his Ph.D. with distinction (2001) from the Department of Physics at the University of Western Australia (UWA). He currently works as an ARC Post-Doctoral Fellow with the Frequency Standards and Metrology research group there. His current research interests include ultra low-noise radar, ultra high stability microwave clocks based on pure sapphire resonators, tests of fundamental theories of physics such as Special and General Relativity and measurement of drift in fundamental constants and their cosmological implications. He has published more than 40 papers in refereed scientific journals and holds 2 patents.