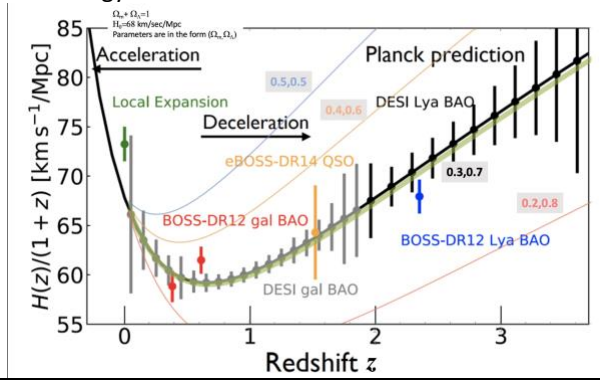
3	Is the gravitational constant dependant upon the density of dark energy	As far as we can tell, the gravitational constant has been the same throughout the history of the universe. We believe this because using a constant value for the gravitational constant in our models of evolution of the universe gives us results that match observation. The same is true for the density of dark energy; the following figure shows excellent agreement between measurement and theory and the theory assumes constant dark energy density. The figure in the data reaches back to about 1.55 billion years after the Big Bang and the data (black dots) matches the theory (green line) all the way back by assuming constant gravitational and dark energy values. 	C o l i n
4	if the universe is expanding, doesnt that make navigating it difficult?	If one could approach is the speed of light, a consequence of Einstein's theory relativity is that all light in the universe is confined to a narrow cone in front of the moving object. That would make navigation very difficult since you need to navigate between the bright objects like stars and they are all in a clump right in front of you at close to the speed of light. That effect has nothing to do with the expansion of the universe. It would occur even if the universe was not expanding	Chris Hale
5	I gather that the future energy is beyond wind & solar energy? Are you familiar with which one(s) it is please?	This question is not clear to me. Furthermore, it has very little to do with the topics I addressed in my talk.	Mabel
6	if due to big bang the expansion is omin directional. is it possible to obsever the universe from the galaxy expansion and direction to estimate the centre of the big bang	There is no center to the expansion of the universe. All observers see all other distant objects moving away from them. Consider the case of the ants on a sphere that I mentioned. All ants confined to the sphere see all other ants moving away from them if the sphere gets bigger. In fact, all observers in our universe see a slightly different group of galaxies because the observable universe for each observer depends on where they are but none can claim that they are at the center of the expansion.	Ching Man

7	The assumption that the universe will carry on expanding at an ever increasing rate due to the influence of dark energy cannot be stated with certainty, surely. Physics we are not currently aware of, may in the future, lessen the impact of dark energy. Therefore the possibility must still remain that the ultimate fate of the universe will be either, still expanding but at a lesser rate; become static; or indeed contract.	Of course, we cannot know for sure if our current theory of the expansion of the universe is correct. However, if Einstein's equations are correct and the properties of the universe that we currently measure (such as the density of matter and the density of dark energy) are correct, we are confident that the universe will continue to undergo an exponential expansion without end.	Ed L
8	If the experiment with the plates is done in space would the result be different. It could be that the amount of space foam is influenced by the amount of matter present. Leading me to the conclusion that the speed of light may be the part of the equation that doesn't work. Perhaps because time is a function of probability rather than a constant, c is the observable fastest speed.	The energy density of a vacuum revealed in the Casimir effect is so large compared to the energy density that astronomers find in space between galaxies that the latter effect would never be detected. Remember that I said that the energy density in the laboratory experiment is 10^{120} times bigger than the vacuum effect we see related to the expansion of the universe.	Neil
10	Where do wormholes fit in with dark energy?	I can't say that there is no connection between these two topics, but we know so little about wormholes that they are not part of any serious theory at this time. There are those who think that dark energy could be an effect arising from an intersection of our universe with universes that are invisible to us because they are only detectable in dimensions that we are not aware of. To follow up on this idea you might want to read books by Brian Greene or Lisa Randall.	Ian Mackintosh
11	Thank you! The search for dark energy seeks to explain the observed expansion of the universe. Do we have any handle on the physical cause of inflation in the early universe?	This is one of the great questions in cosmology. The inflationary theory explains several issues that were troubling prior to its introduction. However, there are many scientists who doubt the validity of the inflationary theory for a variety of abstract reasons. These issues revolve around the entropy of the early universe and why it was so low. It will take more work on both the theory, which has gone through several different iterations, and measurements that described the early universe to really resolve if inflation is on a sound footing.	Ian B
12	How can I get a copy or recording of this excellent webinar, please? Steve Spedding		Spedding Consulting
13	So from this, we are no longer looking at a traditional heat death scenario of an expanding universe, we could be looking at an	The university in the far future having undergone exponential expansion for 10s of billions of years will suffer a heat death. The current radiation background at 2.7 degrees will cool to a much lower temperature in the far future, eventually becoming so cold that its detection will be impossible. Moreover, future astronomers will not have the benefit of being able to	Stephen Cuddihey

	infinitely wide universe that still retains the energetic functions it currently has?	see the billions of galaxies we can currently detect and as a result we'll have virtually no clues as to the origin of the universe. The only objects they will see will be those associated with the galaxy that results from the merger of Andromeda and the Milky Way. That won't provide any information about the existence of other galaxies that have become so distant that they are no longer observable.	
14	Is dark matter continuously being converted into dark energy?	There is no evidence that dark matter is converted into dark energy.	Chris Sturgeon
15	Assuming that our Solar System is not in the center, it must be that some galaxies are moving in the opposite direction to us, whilst other are moving our way but getting further away. Do we know where the centre of the expansion is?	It is true that some galaxies (the closest ones) are moving toward us due to their gravitational attraction to the Milky Way. The more distant ones are moving away from us, and we see that Hubble's law (more distance means more velocity) is true even for the most distant objects. There is no 'center'. All objects are moving away from all other objects. To reiterate, using the analogy of ants on a sphere, all ants we'll see all other ants recede from them.	Howard Williams
16	From Barry - we will never be able to resolve this problem because we will need to make observations billions of years in the future to compare with the theory. Since species on average only survive for a few millions of years we are doomed to remain ignorant as we will not exist billions of years in the future. Also Ed as you just stated, we will not be able to see any other galaxies billions of years in the future. So no future observations will be possible. Shucks.	it is true that in the very far future those looking at the night sky will only see the remnants of the merger of the Milky Way and our nearby neighbor galaxy, Andromeda. After the turbulence caused by the collision of these two galaxies, eventually the resulting galaxy will settle down to something like the spiral galaxies that we currently observe and that will be the only source of light in the universe of future observers. This is a good time to be an astrophysicist because we can see billions of galaxies, measure their distances, and measure their speeds and from those data develop a model of the evolution of the universe.	Barry Pettit
17	One of your graph showed the point where the rate of expansion increased due to the effect of the dark energy mass becoming dominant. Are there any possible conditions in the future which could make a further important change? You have mostly answered this as I typed this question.	First let's qualify the language you use in the first sentence of your question. There is no such thing as 'dark energy mass'. The point that I emphasized was that there was a time about seven and a half billion years ago when the influence of dark energy exceeded the influence of matter of all types, dark and atomic. From that point forward, dark energy asserted itself and will continue to do so evermore. As to whether a future transition to another phase of the evolution of the universe might occur, we cannot say that it will not happen but based on the data we currently have it seems unlikely.	Sarah Parsons
18	What do you consider is the biggest question in Astronomy today?	There are three major questions dominating astronomy today. 1) What is the nature of dark matter? 2) What is the nature of dark energy? 3) Why can't we settle on a specific value of the Hubble constant that agrees with measurements done by a variety of different methods. Answers to these questions will likely require tailoring of our model of the expansion of the universe defined by Friedmann and Lemaitre as well as deeper understanding of the types of particles that exist in the universe as might be revived revealed in the accelerators that are being used to explore the subatomic world.	Sarah Parsons

19	Have you got any particular questions that you think the James Webb telesope will help to answer?	The James Webb Space Telescope has many ambitions. Probably their most important task for cosmology is to see back to the earliest galaxies with greater resolution than we have ever had before and to collect information about the dynamics associated with the formation of those galaxies. Webb operates at wavelengths that will allow it to see through dust and gas into the interiors of ancient galaxies in a way that the Hubble Space Telescope and ground-based telescopes cannot. By seeing deep into the centers of those galaxies we have a chance to compliment the work being done with gravitational wave sensors to understand whether black holes were present in the early universe and galaxies formed around them or whether the opposite occurred.	Sarah Parsons
20	Wonderful talk - Thank you so much!	Thanks for the good words I hope to come back and talk to you and your group again sometime in the future on related topics.	Sarah Parsons