A Quantum Thinking: Light From The Cosmos

I was hardly five when I was first hypnotised by the twinkling lights in the night sky and the glistening moon, awestruck at their beauty, enormous sizes, and vast distances from us. Most of our knowledge about the cosmos is from its light. This cosmic light has changed our lives and our understanding of the world, leading us to the creation of the field of astronomy as our questions increased. It is this light that now allows us to marvel at the universe’s wonders using spectroscopy and Fraunhofer lines. Without light, astronomy would never have existed.

Soon, it was as though I was bombarded with a series of questions for which I had no answer. Why is everything we see the way it is? Why is there so much order in the universe, yet why is it governed by principles of uncertainty? The more I inquired about quantum physics and Einstein’s revolutionary theories of relativity, the more perplexed I became. After extensive research in search for answers, I came across loop quantum gravity (LQG). Though it has its drawbacks, by far, it is probably the most convincing theory in uniting two monumental theories: quantum theory and general relativity.

In the early 1960s, scientists came across a bizarre class of ‘stars’. These stars were unusually bright for the distances their enormous redshifts suggested. After extensive research, it was concluded that this phenomena was created by matter succumbing into monstrous supermassive black holes at the hearts of galaxies. This matter heated up due to friction, radiating light. Quasars are the wildest instances of a category of galaxies with accreting central black holes – active galactic nuclei or AGN, which release huge amounts of radiation at extreme ranges. But is that all they are? We may not be seeing the real picture – perhaps they are evidence for something even more profound.

LQG – one of the two theories (the other being string theory) that has managed to theoretically accomplish what scientists have been attempting to achieve for decades. This theory predicts that space has a granular structure; it is not infinitely divisible. While string theory brings back an imaginary background space by undoing Einstein’s general relativity to avail a background space for all calculations, LQG actively incorporates general relativity, confronts the problem that background space does not exist, and rebuilds quantum theory wherein background space is not a requirement.

Towards the end of the 19th Century, Michael Faraday and James Clerk Maxwell brought forward a perception – a field – visualised as a collection of lines that can exist when no charges are present, and have their beginning and end on electric charges. These Faraday lines construct closed loops since they have no ends without charges and perceived as “quantum excitations of the field” as stated by Italian theoretical physicist Carlo Rovelli. The drawback: two loops that are separated by microscopic distances imply that they are separate and have innumerable loop variables to explain the extent of freedom of the field. Unseen was the realisation that the loops themselves *are* space since they are the quantum excitations of the gravitational field. There are loops on loops, interacting with particles like a proton-electron interaction.

“A theoretical construction must remain humble until its predictions have been directly tested” – wisely stated by Rovelli. We may not be too far, though, from witnessing direct evidence to prove loop gravity.

Scientists have suggested a possible test for LQG. Black holes give out radiation (Hawking radiation) and ultimately evaporate. Scientists propose that this radiation could actually indicate imprints or “footprints” of LQG. The showstopper: Hawking radiation has never been detected in outer space; physicists have claimed to observe it in laboratory conditions only. Though challenging, if detected, mankind will have its greatest scientific breakthrough – it would have the ‘Grand Unified Theory’. In an encouraging statement by Aurélien Barrau of the French National Institute of Nuclear and Particle Physics, “We should be honest: this detection will be difficult, but it is far from being impossible.”

So, if space-time is granular, it can essentially reverse gravitational collapse – expansion. Black holes and their opposite white holes could be the same entity only that we are viewing them differently. As matter succumbs into the black hole, it builds tension in the loops of space. Eventually, the matter would be projected outwards in a white hole explosion. Humans, as outside observers would be deceived by the view of the black hole stage lasting for a billion years due to time dilation. The conversion from black hole to white hole would occur virtually immediately after the formation of the black hole. This is quantum bounce.

Perhaps we don’t even receive the right amount of light we should to deduce the answers to these questions. Black holes don’t allow light to escape. Similarly, in “nodes” where there is a higher concentration of dark matter, perhaps gravity is strong enough to trap light. After all, dark matter makes up approximately 23% of today’s universe. It wouldn’t be unusual to eventually find out that we don’t receive massive chunks of information i.e. light. These concentrated “nodes” may be black holes in disguise.

In the case of LQG, my view of the cosmos is that black holes, white holes and quasars, could ultimately be the same entity; the bulk of what we know is from the light we receive – we have not mastered space travel yet! Black holes are the first stage of this cycle, white holes follow immediately after, and then come the quasars. Since the white hole is the gravitational reverse as granular space-time bulges outwards, the loops would have to return to their original figure. As these loops bend inwards, matter follows and is heated and accelerated to such an extent in this process that it glows luminously, outshining several celestial bodies. It is a quasar.

Ultimately, the Big Bang could possibly have been a white hole explosion. At a certain point in time, the black hole had perhaps engulfed another universe and released it as a white hole to create the universe we know. If eternal inflation is false and the Big Crunch was to occur, this process of creation and destruction is nothing but a cycle. Light as we know it, may have originated from this colossal black hole.

 Where did the matter for the “first” Big Bang come from? Or was there never a beginning? – Everything is the way it is now because it was the way it was then. Ultimately, it all comes down to the same question: how was the universe we see created?