Quantum Astronomy

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(1*) Telescopes and microscopes.* A telescope and microscope are much alike. Both are magnifying instruments designed to collect, magnify and focus a tiny incoming patch of light. The telescope is a good deal larger because the amount of magnification required is greater. The microscope receives reflected light while the telescope is the direct recipient of light from distant sources. In most other respects they are similar. Neither of them are able todiscriminate at the level of molecules, atoms and elementary particles. For this purpose the microscope is replaced by the cyclotron and the Wilson Cloud Chamber, instruments which must take into account both quantum uncertainties and relativistic speeds.

Such considerations, to date, do not figure into the design of telescopes, but it is not hard to imagine that a time will come when this will be necessary.Note that in the data generated by a telescope there is no way to directly determine the distances at which stars and galaxies are located.

Except for the small class of objects which are close enough to us to compute distances from parallaxes, all of the enormous distances in the astronomical catalogues are theoretical. Often they are based on nothing more than guesswork,granted very sophisticated guesswork: light shifts, Cepheid Variables, Russell-Hertzsprung sequences, etc. These distances have often been shown to be off by huge amounts.

In other words, the telescope cannot differentiate between light from a very distant object and light from something very close to us. What the telescope actually collects, and astronomer actually looks at, is the light from a portion of the sky that translates into an

extremely tiny patch of glass on the lenses and mirrors of their instruments. And, when one is dealing with the very small, nearly infinitesimal, one has to acknowledge the presence of quantum effects and the Uncertainty Principle.

Heisenberg's Uncertainty Principle (note aside: there is a very funny use of this principle in Joel and Ethan Coen's film masterpiece, "The Man Who Never Was"),states that the error in distance measurements is inversely proportional to the error in momentum measurements. This principle says nothing about the distinction between telescopes and microscopes. It is a statement about accuracy in measuring small distances and nothing else.

Thus, if observational astronomy ever reaches the stage where the patch of sky under examination enters a region of the telescope in the neighborhood of atomic dimensions, the Uncertainty Principle will guarantee that the momenta of the objects discernible in that patch (which are inversely proportional to the wave-lengths, thereby directly proportional to the red-shifts) , will become impossible to determine. The use of the Hubble Expansion for calculating distances, indeed the expansion itself,breaks down at this point.

Here are some rough calculations:Let R be the radius of a carbon atom R = $77.2x10^{-12}$ m Typically,a quasar will be about the size of the Solar System. Taking the orbit of Pluto as its outer boundary, the distance of Pluto from the sun is P= $6x10^{12}$m. The length of a Light Year is meters is given by L = 10^{16}m.Therefore,given a telescope of focal length of one meter, a carbon atom on the surface of its lens can block the in-coming light of a quasar at a distance of:
D = P/(RL) = .75 Billion Light Years. Multiplying by the focal length allows one to extend this figure, but one sees that any observation in the neighborhood of 14 billion light years must take

into consideration sizable quantum effects at the level of the observational instruments themselves.

One can therefore make an argument from Quantum Theory itself that it may be intrinsically impossible to "see" what really "happened" at the moment of the Big Bang. This may be rather a good thing, generally speaking. As the present Pope sternly warned Stephen Hawking, God doesn't want us to know what happened at that moment anyway. And he may have set things up in such a way that we can't.

The scale under consideration is that in which atomic distances within lenses and mirrors become important. The quantum mechanics of the observation of radiation from distant sources is being transferred to the earthbound materials needed to observe it.

We have discovered yet another area in which quantum mechanics and General Relativity enter in a direct interaction. For, if the patch of light falling on the lens is infinitesimal, yet the objects contained in that patch, from which the light has been emitted, are gigantic, from a world that can only be described in the language of General Relativity. The total description of them must therefore involve both Quantum Mechanics and General Relativity, two theories standing almost directly in contradiction to each other.

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