Published in : *Reality, Science and Value: Is Nature Ever Evil?* (W.B.Drees, Hsg), Routledge: London, 2002

Tragedy vs. Hope: What Future in an Open Universe?

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Summary

Recent evidence from astronomical observations suggests that the universe will expand forever. Nevertheless, all cosmic structures from galaxies to planets and even the matter of the universe itself are bound for decay and destruction. Life cannot continue forever, as the planet Earth will become inhabitable, the Sun will burn out, and the Galaxy will contract to a black hole. The history of all things ends intrinsically tragic.

On the other hand, the past history of the universe is full of spontaneous appearances of new. Not only new stars and living beings have been formed and are still being born, new dimensions for development have opened that did not exist in the beginning.

Will this cosmic creativity continue in the decaying universe, and is there any hope for this universe? Hope for something new is an emotion based on existential sensations. Religious hope expects the new from beyond this space and time. Science and faith thus will and must remain in dispute concerning the future. The outlook into the future is the test for the significance of the propagated values and of the dialogue between science and religion, which has in the past been constricted to the issues of past evolution.

Observations of distant supernovae have shown that their parent galaxies move slowlier than expected in a uniformly expanding universe (Riess et al. 1999; Perlmutter et al. 1999). As the light that reaches our telescopes today was emitted a long time ago, the result means that the universe was expanding slowlier than today. In other words the expansion of the universe is accelerating and will probably continue forever. Does that mean that the universe will exist eternally? Maybe, but certainly not in its present form.

Most ethical thinking and acting is oriented towards the future and based on a certain expectation of it. The future is the primary nexus of ethics, science, and religion (Benz 2000). The past development of the universe makes it clear that the evolution of the universe is very innovative and impossible to predict. We will have to distinguish the various forms of perception leading to different prognoses and expectations.

Thesis 1
All things in the universe decay.

Predictions have played an important role in astronomy since its beginning. Old Egyptian astronomers were able to predict the yearly flooding of the Nile river, and Babylonians could predict lunar and solar eclipses. The goal of today's astrophysics is the understanding of the formation of cosmic structures, their evolution and decay.

The planet Earth is bombarded by meteorites, and occasionally such impacts have lead to major catastrophes. Their influence on the biological evolution was profound, but life on Earth has continued. This will not be the case forever. The Sun has fused already a few percent of its hydrogen fuel into helium. The pressure in the center has augmented and the fusion rate increases. Since the formation, the Sun's luminosity has grown by 40%. Our star will enter the red giant phase in 5.5 billion (10^9) years. The surface temperature will sink to 3000^{o}C, but the diameter will increase by a factor of one hundred. For this reason the temperature on Earth will rise beyond a thousand degrees, too hot for any life. Our planet will no longer be habitable.

After the red giant phase, the Sun will contract to a white dwarf and will cool out over 10^{15} years. Since the size of the Sun will then be only about that of Earth, it cannot radiate enough to heat the Earth significantly. The temperature on Earth will approach the frigidity of space at minus 270 degrees.

Perhaps life will migrate to other stars and planetary systems. However, this is not possible for infinite time. New stars still form, but the hydrogen in our galaxy will last for only some 100 million future stars. The last stars will develop at the edge of the Milky Way, possibly triggered by a collision with another galaxy. Sometime in 10^{13} years the epoch of star light will end. The last white dwarfs will cool and no star will shine anymore.

Galaxies loose energy by the very rare encounters between stars. Gravitational waves carry off energy, and some stars may be sling-shot out of the galaxy. The orbits of the remaining stars contract and the diameter of the galaxy shrinks. The remains of stars will eventually disappear in the central black hole of the Milky Way, where gravity is so large that even the emitted light falls back. The central black hole currently contains 2.7 million solar masses and is located at 25000 light years from here.

The matter outside black holes does not live infinitely, as even protons, the most stable nucleon, will radioactively decay. According to the prevalent but still speculative theories, protons and with them all other matter will decay in about 10^{33} years. Their decay produces positrons and photons.

Even black holes do not live forever. They emit probably a weak thermal radiation at their horizon and thus lose energy. After some 10^{100} years the massive black holes in the center of galaxies will evaporate in this way and disappear. The universe will finally consist only of photons, positrons, and electrons. Although the very distant future is still speculative due to uncertainties in the physical theories, it seems unavoidable that all cosmic objects and even the universe itself will decay.

Is the universe a tragedy, where innocent individuals are bound for destruction? Is the existence of heavenly bodies, animals and human beings an absurdity without purpose nor meaning?

Thesis 2

The evolution of the universe has been extremely creative. The very possibilities for the formation of matter, galaxies, stars, planets, and life have developed only in the course of time. Even today new things are forming.

In our Milky Way, a regular galaxy of a few hundred billion stars, about ten new stars are born every year. The formation of stars takes roughly ten million years. Some hundred million stars thus are forming today in our astronomical neighborhood. The cosmos overflows with fertility.

Stars evolve from interstellar molecular clouds, well-known for their beautiful, fluffy, dark structures. In places where the gas is denser, gravity attracts more gas. The fluctuation gets denser and attracts even more, so the process reinforces itself. The interstellar matter concentrates gradually into cloud cores until these collapse under their own gravity. The gas then falls freely towards the center of the core where the remaining angular momentum forms it to a rotating disk.

After ten million years the temperature and density in the center become large enough to start the fusion of hydrogen to helium. Nuclear energy of stupendous proportions is unleashed and the additional gas pressure stops further contraction. In the innermost part of the vortice an equilibrium is formed between gravity and pressure: the star is born.

The cosmos as it appears today to the observer did not emerge in the Big Bang. Even the simple hydrogen atoms formed half a million years after the beginning. The Sun's age is only one third of that of the current universe, about 14 billion (10^9) years. Human consciousness has existed only for a few hundred thousand years, one hundred thousandth of the age of the universe, thus in the cosmological present.

When we look up at the starry sky on a clear night and believe that at least the stars are the same as always, this impression arises from the fact that our time-scale is too small. In reality, the universe displays amazing dynamics; the origin of stars and formation of planets only represents one segment of processes that build upon earlier cosmic events such as the formation of matter out of elementary particles in the early universe or the origin of galaxies. Qualitative development is a fundamental characteristic of the cosmos, and time plays a crucial role.

The cosmos materialized not like in a theater when the curtain raises, the stage is set, and the play begins. The universe formed much more dramatically, as if in the beginning there was only a glowing magma that solidified to stone from which a building was made. Therein a workshop for stage constructions and an actors' school appeared, a stage and the auditorium were built, everything collapsed, was rebuilt etc. and finally our play started.

Thesis 3
The notion "God" does not appear in astrophysics. When scientists communicate their observations and theories they do not use this term.

Is a creator involved in this dynamic creativity? For more than two hundred years scientists pointed out again and again that this hypotheses is not needed (e.g. Laplace 1796).

Obviously, much remains unexplained scientifically, yet there are already models of how even the universe may have formed from a vacuum according to physical laws. In this sense there are no gaps in the rational understanding of the universe from the Big Bang to the evolution of humans that could be interpreted only by the action of a supernatural being. Existing gaps are the working fields of scientists, who have the great goal to diminish or to close them.

For philosophers one essential question remains: Why did something form and not nothing? The question addresses the fundamental issue of a principle behind the laws of nature. That all things have formed is indisputable, and considerations similar to Greek philosophers in the fifth century BC on the "foundation of the being" are appropriate. Its modern analogue in a dynamic universe would be a principle of structure formation. Appealing here to God's creative will, however, may introduce a mere metaphysical entity without direct relation to science nor to the questioner.

Thesis 4
The new does not emerge from nothing, but is a new organization of existing or decaying entities.

The physical theories describing the formation of the universe are still very speculative and unproven. Nevertheless, it is imaginable that the universe could have formed from a vacuum containing zero energy but all the physical laws we know today. It could have "borrowed" energy against gravitation during a fluctuation in the primary vacuum. It would follow from this vacuum hypothesis that the universe did not originate form nothing, but from a physical entity and according to pre-existing rules.

Star formation is an example of how new structures are created even today. Nonetheless, it is not an eternal circle. When the energy is exhausted, stars shrink to white dwarf stars or explode as supernovae and heave a part of their matter and ashes into interplanetary space. There, new stars form again and in addition completely new structures, planets, emerge from the cinders of previous star generations.

Similarly, the extreme order constituting living beings cannot last. Death is unavoidable for several reasons ranging from chemical decay to physiological deterioration. It is, on the other hand, a necessary ingredient of evolution. Animal species can persist only by selective adaptation in a sequence of generations. Through the death of individuals, a species survives when conditions for life change. In special circumstances, possibly given by unusual environmental stress, extremely rapid evolution may lead to a new species.

Thesis 5
Within the frame given by the conservation laws, the future is open. The universe is not a clockwork.

Today's technology is based on conservation laws, such as the constant energy in a closed system. There are other physical parameters conserved in processes of nature. The conservation laws allow to predict the future of a system, as for example our solar system

including the nine planets, but only to a certain extent. The view into the future is limited for almost all natural systems because they are only weakly stable. This means that a small deviation from the initial orbit will bring the system into an orbit that deviates increasingly at an exponential rate. Such systems are called *chaotic*. Although the systems behave causally, their development cannot be predicted after a certain interval, called the Lyapunov time. This time horizon depends on the system and can be milliseconds in microscopic structures up to millions of years in planetary systems. The motion of the Earth, for example cannot be predicted for more than 100 million years.

Chaos limits qualitatively the description of nature by mathematical precision, and thus the applications of science to technology. The chaotic character of nature also lowers certain expectations raised by the age of Enlightenment, when the cosmos was pictured as a machine, in which individual parts fit together like the gears of a clock according to its given design. If a gear turns at a certain angle, another one rotates the predetermined amount. If the first gear turns at double the angle's size, the angle of rotation of the second gear doubles also. This view of the universe was, without a doubt, linear and does not describe the present worldview of science.

Another limit of the scientific knowing of the future is the uncertainty of quantum mechanical systems. As position and velocity cannot be known simultaneously and with infinite precision, the future development is given only by probabilities.

The chaotic behavior of most systems in the universe and quantum mechanical uncertainty limit the prognostic capabilities of science. What lies ahead is not yet determined and will be decided only later. Whether this openness is intrinsic or follows necessarily from the ever-limited accuracy of measurement would make no difference in practice. The future is open.

Thesis 6

It is quite imaginable that something unexpected could arise in the future that would be as new as life on Earth was four billion years ago. This kind of newness certainly cannot be foretold, for such evolutions are chaotic.

The reliability of scientific predictions is very good concerning for example the exhaustion of an energy supply. The remaining lifetime of the Sun, some 6 billion years, is well known. Its decay is certain. All scientific prognoses of the future – whether for living creatures, planets, stars, galaxies, or the universe itself – thus can only foresee decay at the last. The Sun will become cold, the Earth will lose itself in space, and even the matter in the universe will decay into radiation.

For systems with many interacting parts, like the planetary system or the terrestrial weather, this is different. Their development is unpredictable after a certain time, and thus chaotic. Although the system may be in the process of decay, new structures can form spontaneously in a state of non-equilibrium at certain locations. There is an intriguing asymmetry between the decay of all objects in the universe, which we can predict quite accurately, and chaotic systems that cannot be predicted and that even may form new structures.

Most structures astronomy has detected in the universe have a touch of surprise. Most would not have been predicted if humans had been around at the time of formation. Afterwards they may be explained by causal laws and chance.

Thesis 7

The universe and its development appear to be optimal for human beings. However, there is no scientifically provable hope for new beneficial development.

The universe has properties that are necessary for the developments that have led finally to the evolution of living beings. The basic physical parameters are precisely such that life could arise. The properties of the carbon nucleus, for instance, are favorable for its easy forming in nucleosynthesis, but not so for oxygen, the succeeding element that would have depleted carbon otherwise. The evolution time to intelligent life is about half of the life time of a solar-like star, but not orders of magnitude longer. There are many more of such fine tunings of the universe necessary for our existence.

The Anthropic Principle states that the cosmic and biological developments observed in the past are the a priori condition for the possibility of cognition: "What we can expect to observe must be restricted by the conditions necessary for our presence as observers." (Carter 1974). To put it more simply: That we can wonder at all that the universe is as it is, it must be exactly as it is, for otherwise we would not be here to wonder. This principle proceeds from the tenet that the human being is part of the universe and has originated according to natural laws. It reminds us that, as for any observation, the limits of the measurement apparatus (in this case the observer himself) must be taken into consideration.

Historically, the Anthropic Principle was formulated just at the time when it became clear to astrophysicists that the universe had a beginning and that evolution began with the Big Bang. The observed coincidences are a priori conditions for the possibility of biological evolution. They must have been given before we could perceive the world at all. Certain physical, chemical, and biological characteristics are required through them. The Anthropic Principle is yet no explanation of the cosmological coincidences. As established fact that must be fulfilled by any acceptable model of the universe, it is a triviality. The Anthropic Principle, however, makes one conscious of how strongly human existence is grounded in the whole of the cosmos and what consequences follow as a result of this participation for our theoretical cognition.

To explain coincidences on the level of the whole universe, there appear to be three possibilities:

1. There are physical reasons which we still do not understand why the universe must be exactly as it is (the causal explanation).
2. There are many universes. We inhabit one that has the correct characteristics for evolution and for life (the selective explanation).
3. The universe is given a direction, the goal of which is to create life (the teleological or purpose oriented explanation).

The usual methodology of modern science proceeds from what is observed, and seeks a causal explanation. With the selective explanation, the Anthropic Principle becomes a selection criterion among many universes with random characteristics. Each of these

universes would have other basic constants and other conditions at the beginning. Their totality would perhaps be an infinite ensemble of universes. According to the definition of the term "universe," we could, however, observe no other except our own. The extension of the sciences beyond our reality into other, unobservable universes is therefore a step in the metaphysical direction, from which a number of experts turn away on principle.

The teleological explanation (télos Greek = end, goal, purpose) introduces a structure of finality into science. It has been taken into serious consideration, even though it is largely rejected and has unleashed much emotion in the camp of rationalistic scholarship. The new law would ascribe a tendency to the cosmos that enables life to come about, similar to the characteristic of constant energy. Different from energy conservation, for which no scientifically proven exception is known apart from temporary quantum effects, this character of finality would only guarantee the necessary conditions for life and would not be compelling. It seems unlikely that this view will ever find the kind of consensus other natural laws enjoy in physics. Nevertheless, finality is not a stranger to the analytical structure of otherwise causal physics. The second law of thermodynamics contains finality with an assertion pointing to the future – the increase in entropy – without citing a causal basis. Self-organizing processes have an attractor or a goal toward which they independently set a course. It gives them a direction, toward which the causal microprocesses line up. Finality does not contradict causality and does not exonerate science from the task of finding the individual causal events.

The Anthropic Principle explains at least partially why the universe appears "good" for us and made to the benefit of humanity. If there is a development after which the universe can think about itself, the universe must have certain conditions. The Anthropic Principle cannot explain why there is such a development at all.

From the above discussion it must be concluded that the Anthropic Principle cannot be applied to the future. Some developments are predictable from conservation laws with great certainty, but they may not be "good" for us. Some new structures are conceivable, but newness remains speculation.

Thesis 8
Pattern recognition is an important way to perceive. We do not mathematically predict the future, but recognize patterns in the "signs of the times".

Because there are these two counter-streaming, unpredictable developments of decay and formation, recognition of patterns plays an important role. Pattern recognition is a significant way of human apprehension and is distinct from pure measurement. Here we make an important step from the exact sciences to other sciences and finally in the direction of religion. Pattern recognition means that we interpret perceptions and construct their meaning. Two steps are required:

First, out of countless perceptions and experiences human reason selects facts that are considered typical. This selection may occur unconsciously, without reflection or even by a computer. Concerning the future, we search for and select the "signs of the times". The second step in construction is the recognition of a pattern. Patterns are derived from

previous perceptions and experiences constituting mental prototypes. A pattern is recognized by its similarity with the new situation, if the probe and the example agree within a certain margin. Errors can occur when a pattern is not recognized or a pattern is erroneously found to fit. The two-step interpretation by selection and pattern recognition constitutes a successful method for certain problems and has important applications in technology, such as robotics.

The way we anticipate the future depends on how we interpret the present. There is a choice of various patterns: It is getting better; it remains as it has ever been; it gets worse and worse; something new will appear. The forth pattern is central for the Christian hope, where the events of Good Friday and Easter are the archetype. The four patterns are diametrically different. Independent interpretations of the same present may thus contradict each other. Only later experiences will confirm or refute an interpretation.

Interpreting the present is important as the coming future may require preparation, initiative or defense. Human beings are masters of interpretation, very likely because reliable pattern recognition was a selective advantage in the evolution of the *Hominidae*. Those who interpreted well had more chances to survive and to have descendents. The future punishes those who interpret wrongly.

Thesis 9
Hope is not a scientific term. It can only grow in a trusting relationship. Such trust involves a certain foreknowledge with which a person faces the future.

Scientific predictions can be objectively justified. Hope, however, is not independent of a subject. It touches on the relationship between the subject and the world. On the basis of this relationship, reality is perceived in a different way than on the basis of the scientific method. Hopes are based upon promises, ideals or on the perception of the world as creation. Hope cannot be brought about by dogmas or metaphysical constructions but must accord with one's own perceptions.

The Christian tradition does not postulate the sort of optimism in which the development of the world is seen as a straightforward progression toward the good and the reasonable. Its hope lies not in protection from crisis, but rather in the formation of newness. The last book of the Bible, the Revelation of John, expresses this perspective in apocalyptic visions. Hope is established within a divine dimension of time, namely its creativity. The crisis will be overcome without specifying, how this will occur in concrete terms. It is not easy for scientifically-minded people to accept a hope for which there is no causal justification The scientific pattern for “the formation of newness” cannot establish Christian hope, but can make hope understandable by supplying relevant metaphors. As with the concept of creation, the scientific “how” must recede into the background, where hope for the future is concerned.

The apostle Paul expressly describes the resurrection of Christ as the basis for Christian hope (1 Cor 15: 12-19). What took place on Good Friday followed by Easter, says hope, will occur again in some comparable fashion. The experience-pattern of crisis and redemption has this precedent by which hope can be gauged at any time. It is not surprising if Christians always come back to that. Moreover, the transcendent basis for hope becomes

obvious in this prototype, since the resurrection appeared as a part of this new to come from beyond space and time. Christians hope for nothing less than newness in the realm of death and in a world of merciless decay; in religious language, they hope for a new creation.

Thesis 10

Many of our perceptions, in particular relating to the religion and the expectations of the future, cannot be objective as the human being participates and is part of the process.

Scientific measurements and observations must be reproducible and objective. The researcher is exchangeable and the result independent. In religious perceptions, on the other hand, a human being is always strongly involved. I would not say that such participating perceptions are purely subjective, as they are often reported as a relation to an outside entity. Such perceptions are universally human and change the life of many people in a visible and often very positive way. If "reality" denotes what has a lasting effect in real life, these changes testify to the experienced reality. The human being directly takes part in the process of perception and is the observing instrument. Thus the observer is not interchangeable, similar to experiences of art. It follows that seminal perceptions are the very starting points of both science and religion. However, they are fundamentally different. The two fields of experiencing reality consequently span two different planes of methodology and language.

It leads to misunderstandings and false expectations in the present discourse between science and theology, when the two planes of perceptions are not clearly separated. This difference is the reason why science can neither prove the existence of God nor deny it. It is as hopeless to find a compelling trace of God in scientific results as to find a palm tree in a Canadian forest. There is no direct path from scientific measurements to religious experience.

The path can only be indirect and through the human consciousness. For example, the apparent fine tuning of the universe to the benefit of evolution is certainly amazing. If a person believes in God based on other experiences, he or she can apprehend in the cosmic evolution the work of God. Only then the fact that something has formed and not nothing (Principle of Formation) becomes what is meant by the biblical concept of God. Without participating perceptions it remains an abstract principle.

It is worth recalling that no objectively certain facts are available concerning the Easter event. The Good Friday - Easter pattern makes sense only on this other level of perception – the participatory level, where subject and object meet in an interactive relationship and form a whole. So neither the pattern nor the hope can be regarded as objectified facts. Christian hope does not follow from an interpretation of nature independent of the observing person and cannot be objectively confirmed. It cannot even be made plausible to scientific reason. Like love, hope is not compulsive, but is rather something like a gift that one can accept or not. Hope is no abstract idea, for ultimately hope becomes integral to one's humanity and changes nothing less than the condition of human life.

If we speak of "hope contrary to all reason," we acknowledge that the factual appearances as observed in science do not define the whole of reality.

Thesis 11
Hope is based on participating perceptions.

How does one arrive at such hope? In hope, religious experience expresses itself on the level of faith. Such experience formed originally from elements of existential sensory perception, particularly in everyday's life. It also includes relational, "interior" perceptions of wholeness, dreamlike visions, or sudden insights while completely conscious. The traditional pattern helps to identify and to integrate these perceptions. Living with hope, I do not perceive time only as a sequence of causal processes or chance occurrences, and as an infinitesimally brief present. Once the hoped-for future enters the picture, time embraces duration. It is the duration of waiting until newness forms. Through attentive waiting, we may occasionally discover foreshadowings and intimations of the future newness. But this kind of perception requires patience, and a willingness to develop a reciprocal relationship to reality.

The tension between science and religion concerning the expectation of the future cannot be fully harmonized and must remain. It is the tension between practical knowledge and visionary hope. This tension is within ourselves, not between fields of inquiry, and it is an important part of reality and of our life.

Thesis 12
Nature has always been a source of metaphors for experiences on the level of participating perceptions. Today science has partially and unconsciously taken over this role.

The two planes come into constructive contact when a pattern of one plane serves as an image in the other. This comes about when a religious experience is expressed by a metaphor (Greek for *transfer*) from science. A metaphor transfers a well-known pattern (e.g. "formation of new structure") into the other plane of concepts. The notion of "hope" could thus be communicated by the following metaphor:

Despite decay and death something new will arise out of this existence, just as our planet formed from cosmic dust, the ashes of former stars.

The hope that is expressed here cannot be deduced from the physics of planet formation, but must originate in the plane of religious perceptions where this boundless confidence is experienced.

Hope for new is one of several patterns for the interpretation of the signs of the times. If we live with this pattern, the past development of the universe may become a metaphor for the future of our existence. And more: By interpreting scientific results they are evaluated based on other, additional experiences. The scientific facts then appear in another perspective and in a different light: The universe is revealed as a continuous creation not a horrible tragedy, and there is hope for creation also in the future.

References:

Benz A., The Future of the Universe: Chance, Chaos, God? (Continuum: New York, 2000).

Carter B., in Confrontation of Cosmological Theory with Observational Data, ed. M.S. Longair (Dordrecht: Reidel, 1974), p. 291.

Perlmutter S. et al., Measurements of Omega and Lambda from 42 High-Redshift Supernovae, Astrophysical Journal 517 (1999), 565–586.

Riess A. et al., BVRI Light Curves for 22 Type I A Supernovae, Astronomical Journal 177 (1999), 707–724.