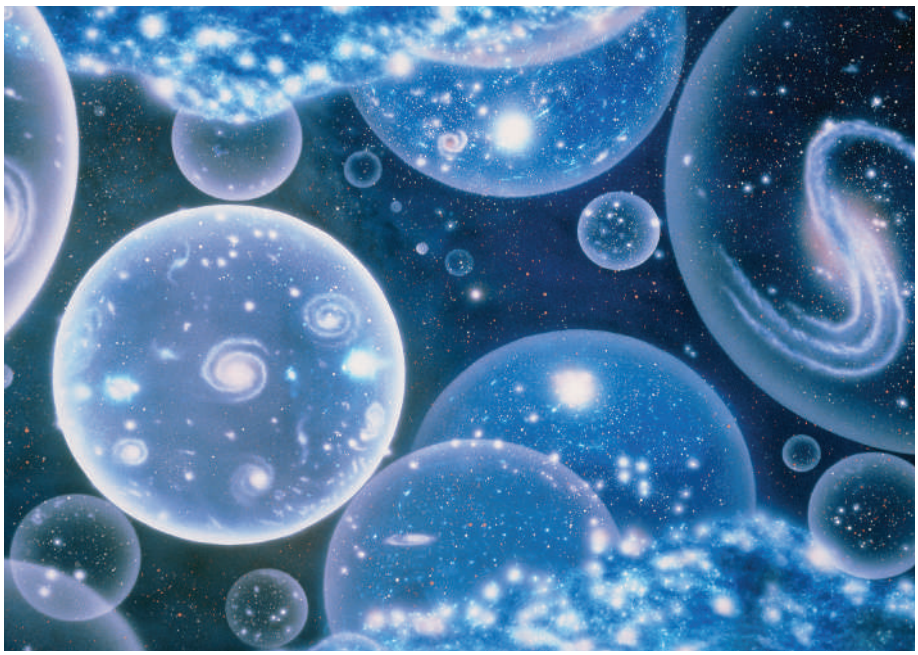
BOOKS & ARTS

# Our place in the Multiverse

**Was the appearance of a Universe that can support life inevitable?**

**Many Worlds In One**
by Alex Vilenkin
Hill & Wang: 2006. 248 pp. $24

**Joseph Silk**



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**Bubble vision: theories of quantum gravity suggest that the Multiverse may contain $10^{500}$ universes.**

The smallest person in the world, an Indian called Gul Mohammed, had a height of just 57 centimetres. The tallest, an American called Robert Wadlow, measured 2.72 metres. But the observed distribution of human heights fills only a small part of the range in between. Why? The average is about 1.63 metres, a respectable height for much of the world's population. Where are the giants of fairy-tale fame? And where are the Lilliputians?

We know the answers. Our genes control the supply of the growth hormones that spur our bones to elongate. Genetic abnormalities can reduce the abundance of these hormones in dwarfs, and oversupply leads to giantism. The environment, most notably nutrition, also plays a part, and gravity constrains our height — we are taller after sleeping, and astronauts gain height in space. Genetic evolution, with help from physical constraints, has narrowed the height range to the observed distribution.

Here we can reconcile observation with theory using known physics and biology; there is no need to invoke another explanation, such as a Grand Designer. But does the same kind of reasoning apply when scientists discuss our place in the Universe? In his stimulating new book, *Many Worlds in One*, cosmologist Alex Vilenkin invokes the anthropic principle in his interpretation of the Universe we observe: it is the way it is because we are here to observe it.

There are many possible universes that are inhospitable to our existence. The latest theories of quantum gravity count some $10^{500}$ realizations of the universe, in which the various fundamental constants of nature differ. In this Multiverse, all universes are equally real, although we can only hope to explore our own one. Given the staggering array of alternatives, it is exceedingly unlikely that our observed universe should even exist.

Take the mystery of dark energy, for instance, which dominates the energy density in the Universe. Our best theories predict a value for the amount of dark energy that is too large by a factor of $10^{120}$. It is a tautology to assert that our existence selects an appropriate universe from the ensemble of all universes. After all, we can only observe a universe of a certain size, old enough for stars and planets, and for life to have developed. But it is physics, or at least metaphysics, to state, as the physicist Robert Dicke first did, that the Universe must be old enough for stars to have synthesized carbon, a necessary condition for our presence. It is one further logical step to assert that the values of all of the fundamental constants of nature, which may vary throughout the Multiverse, are determined by our presence. This is the anthropic principle in its weakest form. It is simply observational selection, with the caveat that our presence is not guaranteed.

A strong version of the anthropic principle claims that intelligent life is inevitable somewhere in the Multiverse. But let us put that aside, if only because strong anthropic arguments are weakened by the inclusion of a possibly infinite age for the Universe. A great deal can happen over a long time in a universe that perpetually renews itself by eternal inflation. The weak anthropic principle, preferred by many of my colleagues, selects only the small subset of 'pocket universes' within the Multiverse that allow galaxies to form and life to develop. There is then a high probability of finding only a small but non-zero value for dark energy today, which is what we observe.

At least three rival hypotheses could explain the values of the fundamental constants of nature. First, the selection could have been made by a Grand Designer. This has great appeal to proponents of the intelligent design of the Universe. Vilenkin argues forcefully that there is no need to invoke such a concept, although ultimately it reduces to a question of personal belief. The second option appeals to currently unknown physics. The height distribution of human beings can be understood by known rules, so there is no need to invoke another explanation; perhaps we simply do not yet know the rules for navigating in the Multiverse. It may be that it takes an infinite time to populate the plenitude of potential universes. The ultimate voyage through the quantum foam that characterizes the Multiverse to arrive in our Universe may take so long that it could only have happened once. If so, it makes no sense to talk of probabilities for our Universe to appear.

The third option, and to my mind the most likely, is that there was no selection at all: we are here because we are here. This is what must happen in an infinite Multiverse. Some versions of quantum gravity appeal to the complexity of the initial conditions to assert that there were an infinity of landscapes and universes in the Multiverse. If this were the case, the game is

over. The dice were rolled and our Universe was inevitable, somewhere in the Multiverse. And here we are.

Remarkably, we can test this hypothesis. Future experiments will measure the curvature of space with exquisite precision. If the curvature turns out to deviate from flatness, we would come to a conclusion unprecedented in human thought. A slightly closed Universe would prove the finiteness of space. A slightly open Universe would go a long way towards demonstrating that space is infinite, at least in standard cosmologies. If this were the case, we would no longer need to invoke any version of the anthropic principle; it would simply be redundant.

I thoroughly recommend *Many Worlds in One*. Vilenkin has made some major contributions to the Multiverse hypothesis. Here he illuminates the current issues with clarity and elegance, yet the stories he tells are accessible to non-specialists. ■

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# Back on track

**Out of the Woods: Tales of Resilient Teens**
by Stuart T. Hauser, Joseph P. Allen & Eve Golden
Harvard University Press: 2006. 327 pp. $27.95

**Ann S. Masten**

Stories of individuals overcoming great obstacles to succeed in life no doubt cast their spell on audiences long before they were recorded in books. The power such tales hold will captivate readers of *Out of the Woods*, an accessible book on resilience by two leading clinical scientists in developmental psychiatry and psychology, Stuart Hauser and Joseph Allen, and independent scholar Eve Golden. Drawing on data from a unique study of 67 teenagers hospitalized for serious behavioural and emotional problems, the authors examine how nine of the troubled teens managed to get 'out of the woods' and on to positive developmental pathways as adults. Their voices emerge from striking interview narratives that span a dozen years, from the time of initial hospitalization (when the future looked bleak indeed) into early adulthood. The achievements and gaps of the resulting book reflect the progress as well as the difficulties of 'resilience science'.

It is intriguing to see a return to case narratives at this particular time in the history of resilience research. Compelling cases often inspired the pioneers who launched the systematic study of human resilience in the 1960s and 70s. Much was learned over the ensuing decades, despite the new field suffering growing pains. A range of diverse studies yielded surprisingly congruent findings about potential protective factors, or 'what makes a difference', although frustratingly few details emerged about how these factors actually work — a situation concisely summarized in the opening chapters.

The heart of the book is focused intensively on the lives of four resilient young people, who are compared and contrasted with each other and with their less adaptive peers. Anyone concerned about young people will find their stories thought provoking. The book reveals the changing voices and perspectives of each individual and shows, in the words of the authors, "how resilience can kick in before it shows". Some of the interview narratives also provide an entertaining and illuminating portrait of unconventional young people thwarting the conventional strategies of their interviewers as the teens struggle to hold their own against family adversity, the indignities of a locked inpatient unit, and the stigma of treatment for mental illness. There are fewer words from the more typical patients; readers must rely on commentary by the authors about the differences.

The case studies emphasize three fundamental protective factors, each a long-standing member of the resilience hall of fame. The first is the presence of positive relationships, encompassing the attachment system and the human capacity for recruiting and forming lasting bonds with parent figures, partners or mentors. The second is agency, the capacity and confidence people have for steering their own lives, and the reward systems that motivate efforts to overcome obstacles and control what is happening in one's life. The third protective factor is reflection on one's self and situation, and the requisite cognitive systems for directing attention and thought. Readers will find other well-established protective factors in these case reports, including optimism about the future and the belief that life has meaning, access to positive institutions, and the advantages of certain cultural or socioeconomic positions.

Largely missing from these vivid accounts, as well as from the first generation of resilience science, is the role of context and multiple levels of analysis. These cases offer a rare and fascinating glimpse into the lives of hospitalized adolescents who have recovered, yet it is difficult to apply the lessons from their lives to other teens and situations. As the authors point out, many details about the developmental histories of these individuals remain unknown. The general role of developmental changes, in person and situation and the way these interact, is not emphasized. Researchers now speculate that the transition to adulthood provides a window of opportunity for late bloomers, when motivation, cognition and opportunity converge to make positive change possible. Brain development enhances the capacity for evaluating, planning and redirecting one's own life. At the same time, young people encounter new and transformational situations, in the form of higher education, job training, military service, religious service or courtship. There is a new wave in resilience science, based on efforts to understand processes across disciplines, levels of analysis and species (humans and animals). Scientists are beginning to integrate recent advances in genomics, neuroscience and the modelling of dynamic systems into the body of knowledge on resilience.

The book serves as a powerful reminder of the phenomenon of resilience and the compelling rationale for understanding resilience well enough to facilitate it. All these young people have suffered, and only 13% (so far) have made it out of the woods. Their resilience inspires hope, just as individual cases inspired pioneers 40 years ago to hope that science could improve the odds for resilience or prevent children from getting into the woods in the first place. As resilience science matures, the prospects for realizing these goals are improving. Meanwhile, it is important to remember that the woods continue to fill with young people who have lost their way. ■

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**Down but not out: research is progressing on how to help young people overcome their problems.**

N. GOELBASI/GETTY