The 28th annual meeting

The 28th annual meeting of the society took place on March 29th, 2015

Program and Abstracts

Program:

Program of the 28th annual meeting		
Time	Lecturer	Lecture Title
08:45-09:00	Refreshments & Gathering	
Session 1 - Evolution		
09:00-09:10	Nathaniel Wagner (BGU)	Opening Remarks
09:10-09:40	Terence Kee (Leeds, UK)	Towards Convergent Abiogenic Processes
09:40-10:00	Malcolm E. Schrader (HUJI)	Punctuated Equilibria in Geobiological Evolution
10:00-10:30	Addy Pross (BGU)	Evolutionary Dynamics in the 'Regular' and 'Replicative' Worlds: Boltzmann vs. Malthus
10:30-11:00	Ehud Meron (BGU)	Surviving Stress by Pattern Formation
11:00-11:20	Eyal Arbely (BGU)	An Expanded Genetic Code

Program of the 28th annual meeting

Time	Lecturer	Lecture Title
11:20-11:45	Coffee break	
Session 2 - Astrobiology and Prebiotic Chemistry		
11:45-11:55	Prof. Jiwchar Ganor, Dean of the Faculty of Natural Sciences (BGU)	Greetings
11:55-12:25	Pierre-Alain Monnard (SDU, Denmark)	Protocells: Laboratory Models for the Emergence of Living Cells?
12:25-12:45	Amri Wandel (HUJI)	On the Abundance of Exo-Life after Kepler
12:45-13:05	Joseph Gale (HUJI)	Quo Vadis Astrobiology?
13:05-13:25	Danny Portman (Technion)	Adaptable Habitability
13:25-14:15	Lunch	
Session 3 - Planets and Asteroids		
14:15-14:35	Hagai Perets (Technion)	The Origins of Earth's Previous Moons, and Why is the Moon Made Out of Cheese?
14:35-14:55	Sivan Ginzburg (HUJI)	Hot-Jupiter Inflation due to Deep Energy Deposition
14:55-15:15	Harel Ben-Ami (COPUOS, UNOOSA)	Preparing to defend our home - Earth

Program of the 28th annual meeting

Time	Lecturer	Lecture Title
15:15-15:35	David Polishook (WIS)	Near-Earth Asteroids (NEAs) – Delivering Space Material to Earth
15:35-16:05	Noah Brosch (TAU)	Near-Earth Asteroids, Impacts, and How to Mitigate Them
16:05-16:20	Coffee break	
Session 4 - Biochemistry		
16:20-16:50	Peter Strazewski (Lyon, France)	How to Feed an Inanimate Evolvable Chemical System so as to Let it Self-Evolve into Increased Complexity and Life-Like Behaviour
16:50-17:10	Doron Lancet (WIS)	Composomics: a Common Biotic Thread
17:10-17:30	Ute Deichmann (BGU)	The Impact of Scientists' Philosophical and Political-Ideological Views on their Research Related to the Origin of Life
17:30-17:50	Rakesh Mukherjee (BGU)	Bistability and Bifurcation in Reversible Catalysis
17:50-18:20	Sohan Jheeta (NoR HGT, LUCA)	Hypothesis: Network of RNAs and their Influence on Life
18:20-18:40	Tal Mor (Technion)	When Physics Met Information - a Model for the Emergence of Coded Life
18:40	Gonen Ashkenasy (BGU)	Closing Remarks

Abstracts:

Towards Convergent Abiogenic Processes

Terence Kee
President, Astrobiology Society of Britain
School of Chemistry, University of Leeds, UK
t.p.kee@leeds.ac.uk

Activated phosphorus(P)-based energy-currency molecules drive much of the metabolic activity of contemporary biochemistry. Such molecules are able to selectively exploit small tranches of energy (ca. 40kJmol-1 for the hydrolysis of ATP to ADP), when mechanistically coupled, to drive endergonic chemical reactions, their supply of ATP being recharged via mitochondrial oxidative phosphorylation and substrate-level phosphorylation during glycolysis. A significant problem in the field of abiogenesis concerns emergence of a P-based system of bioenergetics which can be shown to perform multiple, and ultimately convergent, chemical processes of potential value to primitive chemical machines within putative early earth environments, without the need to invoke sophisticated (ie: proteinaceous) catalysis. So firmly embedded are activated P-based energy currencies in cellular bioenergetics that it is not unreasonable to envisage such bioenergetics being amongst the most ancient of biochemical machinery. Some challenging problems emerge: (i) could simpler P-based systems have preceded ATP as energy currencies, (ii) how could such systems have emerged within early earth geological environments and (iii) what chemical processes could such energy currency molecules have driven? Pyrophosphate [PPi(V); P2O74-] has been proposed as a logical ancestor of ATP, not least because of a firmly established role for the former in biology. However, problems remain with PPi(V) as an effective prebiotic energy currency, including inherent low solubility in salt-rich waters and low kinetic reactivity in the absence of suitable (enzyme) catalysts. We presume that PPi(V), and by association polyphosphates, would have emerged as key energy currencies only when catalyst systems were available to use them effectively in P-transfer chemistry. We have recently reported on a geologically plausible prebiotic ancestor to PPi(V), the closely related condensed P-material, pyrophosphite, PPi(III) [H2P2O52-] and possible chemical routes for this molecule to be converted to PPi(V) as part of a pathway for chemical evolution. Presented here are some of our first investigations of PPi(III)-mediated chemical processes which may have been of value to primitive chemical machines, the earliest fore-runners of cellular systems. The PPi(III) energy currency system is found capable of (i) coupling amino acids to peptides under mild (ambient) conditions and with a distinct bias in primary sequence based upon physic-chemical properties of the environment, (ii) amphiphile formation via phosphonylation of long-chain alcohols to afford vesicles, again under mild conditions. We subsequently speculate on the significance of converging peptide and vesicle formation in the emergence of primitive complex chemical systems.

Punctuated Equilibria in Geobiological Evolution

Malcolm E. Schrader
Institute of Chemistry, Hebrew University of Jerusalem
schrader@mail.huji.ac.il

The traditional accepted Darwinian approach to biological evolution has advocated gradual changes in species nature until a product that could be described as a new species emerged. EG postulated a series of successive steady states with sharp changes in transition from one species to another. The theory sparked a sharp debate. Opponents presented evidence of various interspecies gradual evolution. EG then pointed out that they had never claimed there was no gradual evolution at all, but rather that there is also important punctuated evolution. In this talk the evidence of punctuation in the broad sweep of geobiological evolution is reviewed. The term geobiological evolution is used since it is clear that evolution of the Earth as a planet and evolution of its biosphere cannot be treated independently but rather interact with one another. This can lead to increased understanding of the overall nature of the "strategy" of biological evolution. The point is, punctuation can be regarded as the result of slow change which reaches a critical point for sharp transition to a new steady state, or alternatively, the result of an accidental external intervention, which leads to sharp transition to the new steady state. Therefore, there is the possibility that not only intelligent life relied on an accident, but that the transition from inanimate matter to animate (living) also relied on an accident. This would mean that any sort of life in the Milky Way outside our solar system may be rare indeed (if there at all).

Evolutionary Dynamics in the 'Regular' and Replicative Worlds: Boltzmann vs. Malthus

Addy Pross
Department of Chemistry, Ben Gurion University of the Negev, Beer Sheva
addy.pross@gmail.com

Living and non-living worlds are strikingly different, in particular with regard the rules that govern change in those two worlds. In this talk we will attempt to show that the nature of change in both biological and physical worlds can be better understood through the concept of stability.1 A mathematical characterization of stability reveals that stability can manifest in two distinct ways, one thermodynamic, due to Boltzmann, based on probability theory, the other kinetic, termed dynamic kinetic stability (DKS) and traceable back to Malthus, reflecting the importance of exponential growth in replicating systems. Two stability kinds based on two distinct mathematical formulations lead to two material forms and two distinct modes of evolutionary change.

1. Pascal R, Pross A: The nature and mathematical basis for material stability in the chemical and biological worlds, J Syst Chem 2014, 5:3.

Surviving Stress by Pattern Formation

Ehud Meron
Blaustein Institutes for Desert Research & Dept. of Physics, Ben-Gurion University
ehud@bgu.ac.il

Ecosystems generally respond to environmental stresses at multiple levels of organization. At the organism level species can change their phenotypes and at the community level shifts in community structure can occur. Another response mechanism that has attracted much attention recently is self-organization in space to form periodic spatial patterns of biomass and resources. Pattern formation of this kind is a population or community level means to cope with depleting resources. A beautiful and environmentally significant example of this response mechanism is vegetation pattern formation in water-limited systems (drylands). In this talk I will discuss mechanisms of vegetation pattern formation, the patterns that these mechanisms induce along the rainfall gradient, and the implications they bear on significant ecological problems, such as desertification and biodiversity loss. Universal aspects relevant to other living systems will be emphasized.

An Expanded Genetic Code

Eyal Arbely
Department of Chemistry and The National Institute for Biotechnology in the Negev
Ben Gurion University of the Negev, Beer Sheva
arbely@exchange.bgu.ac.il

The genetic code of all known organisms has been evolved to use the same common 20 amino acids, with the rare exceptions of selenocystein and pyrrolysine. This repertoire of building blocks may be sufficient to maintain life, but is not ideal, as evidenced by the number of cofactors and posttranslational modifications of proteins. In addition, the incredibly complex translation mechanism has been evolved to decode 64 triple-nucleotide codons, each encoding either one of the canonical amino acids, or the termination of translation. Although evolved to near perfection, this machinery is far from exploiting its full potential as it evolved to incorporate non-canonical amino acids and decode quadruple-nucleotide codons. In my talk I will describe some recent advances in the field of genetic code expansion and the use of these methods in the study of the effects of post-translational modifications on the structure and function of transcription factors.

Protocells: Laboratory Models for the Emergence of Living Cells?

Pierre-Alain Monnard
Department of Physics, Chemistry & Pharmacy
University of Southern Denmark
monnard@sdu.dk

All contemporary living cells are composed of a collection of self-assembled molecular elements that by themselves are non-living but through the creation of a network exhibit the emergent properties of self-maintenance, self-reproduction, and evolution. We will review here on-going research that aims at either understanding how life emerged on the early Earth or creating artificial cells assembled from a collection of small chemicals, i.e., systems designed from the bottom-up, often called protocells. Components of protocells have been long debated and recently a consensus has started to emerge: to be functional, a protocell would need to be composed of a compartment, a reaction network, and information components. But these components can only lead to emergent properties if true inter-connections between their functions are realized. That is, it seems to be necessary to attempt the design of protocells in a systemic approach, i.e., construct a protocell with all its components present even if the exhibited nominal functions are extremely simplified compared to those of cells. The successful construction of a protocell will occur in the future, but the main, current obstacle remains the true integration of all component functions in a single self-maintaining, self-reproducing system capable of evolution. Indeed, even though recent advances have demonstrated that each protocell component, alone or through interactions with one other component, can already exhibit abilities that should be considered emergent properties, none of the currently studied systems has reached the threshold function level required by the definition. Nonetheless several results have highlighted the inherent potential of the systemic approach. Thus, we will report several aspects of the investigations carried out to implement for the protocell functions in complex molecular systems built from the bottom-up.

On the Abundance of Exo-life after Kepler

Amri Wandel
Racah Institute of Physics, Hebrew University of Jerusalem
amri@huji.ac.il

Combining the recent results of the Kepler mission on the abundance of small planets within the Habitable Zone with a Drake equation formalism I derive the space density of biotic planets as a function of the (yet unknown) probability for the evolution of biotic life. I suggest that it may be estimated by future spectral observations of exoplanet biomarkers and that a biotic planet may be expected within 10 -- 100 light years from Earth. Similarly I derive expressions for the distance to putative neighbor civilizations in terms of the probability for the evolution of a civilization and its average longevity. For optimistic probability values and broadcasting longevity of a few thousand years, the likely distance to the nearest civilizations detectable by SETI is of the order of a few thousand light years. The probability of detecting intelligent signals with present and future radio telescopes is calculated as a function of the Drake parameters.

Related Articale from Hayadan website

Quo Vadis Astrobiology?

Joseph Gale and Amri Wandel
Institute of Life Sciences, Hebrew University of Jerusalem
gale.joe@mail.huji.ac.il

Within the last two decades the multi-millennial question of the existence of extra-Solar-system planets has been resolved with the discovery of numerous planets orbiting nearby stars and the results of the Kepler mission indicating that Earthlike planets are common. It appears that on average there is at least one planet orbiting each of the $\sim 10^{11}$ stars of the Milky Way. Oxygenic Photosynthesis and hence eventually complex life, have been considered to be possible on the planets of many Red Dwarf (RD) stars. Moreover, the vast number of RDs, which constitute 70% of nearby stars, and according to the Kepler results are likely to have Earthsize planets, makes the existence of complex life on extra-solar-system planets plausible. In turn, complex life could possibly lead to intelligent life. Within the next decade new space and ground based telescopes will be able to obtain spectroscopic analysis of the atmospheres of "nearby" RD planets, in the search for signatures of life, such as oxygen and methane. The search for broadcasts from extraterrestrial intelligence (SETI) continues. Although in 50 years there has been no success, the optimists have not given up. The next step, after (hopefully) finding tantalizing atmospheric indications of life, would be to send probes, automatic or manned, to make close up studies of any promising planets. However, this is well beyond our present technological abilities and resources. For example, if we detect a promising "neighbor" planet target distance of 10 light years, and assuming that we accelerate our probe to an average speed of one hundredth the speed of light, it would take 1010 years for the first message "I have arrived" to return to Earth. Will we still be around to receive it? Even this is optimistic. With present space technology, it would take more like 10^{5}years to make this one way journey. It may be possible to receive a message broadcast from an intelligent civilization; but for similar reasons of distance, the limited speed of radio messages and short human longevity, two-way communication would be very challenging. Even so, recent history is full of examples of the realization of the predictions of science fiction, deemed in their time by scientists and engineers to be impossible. Heavier than air flight; medicines which kill pathogenic bacteria but not normal human body cells; worldwide communications from pocket phones; access to almost all the knowledge of humanity from the same smart-phones, etc., etc., are but a few such examples. 1700 years ago the Talmud said that "Since the destruction of the Temple only children and fools prophecy" – so who knows?

Adaptable Habitability

Danny Portman (Tsebrenko)
Technion - Israel Institute of Technology, Haifa
ddtt@techunix.technion.ac.il

We examine the possibility of life on a planet that slowly migratesoutside of the habitable zone of its system. If a planet resides within a habitable zone for a period long enough for life to appear and then slowly moves out of the habitable zone due to secular planetary migration, extremophile life on the planet may have enough time to evolve and adapt to the changing environment, if certain conditions are met. Thus, in principle, life may exist on planets residing outside of the habitable zone. In our current research, we examine the physical conditions for such a scenario and derive a planetary migration timescale that may allow life to persevere on the host planet after it leaves the habitable zone. We coin the term “adaptable habitability” to describe this concept. The critical physical conditions for life are extrapolated from the current knowledge regarding Earth's extremophiles.

The Origins of Earth's Previous Moons, and Why is the Moon Made Out of Cheese?

Hagai Perets
Technion - Israel Institute of Technology, Haifa
hperets@physics.technion.ac.il

Earth's moon has attracted human attention since the earliest times in human history. Its origins have been debated as early as the earliest mythologies in all human cultures, and are still strongly debated to this day. The return of Moon material by the Apollo missions has shed new light and given rise to new puzzles regarding its origin. In particular, it was found that the isotopic composition of the Earth is essentially identical to that of the Moon, opening novel questions of how such composition similarity came to be. I will review the various models suggested for the origin of the Moon, their difficulties and successes, and then focus on new results that may resolve some the main challenges to the suggested models. I will also discuss the highly likely possibility that the Earth has had previous moons prior to the Moon we see today.

Hot-Jupiter Inflation due to Deep Energy Deposition

Sivan Ginzburg and Re'em Sari
Racah Institute of Physics, Hebrew University of Jerusalem
sivpro@gmail.com

Combining the recent results of the Kepler mission on the abundance of small planets within the Habitable Zone with a Drake equation formalism I derive the space density of biotic planets as a function of the (yet unknown) probability for the evolution of biotic life. I suggest that it may be estimated by future spectral observations of exoplanet biomarkers and that a biotic planet may be expected within 10 -- 100 light years from Earth. Similarly I derive expressions for the distance to putative neighbor civilizations in terms of the

probability for the evolution of a civilization and its average longevity. For optimistic probability values and broadcasting longevity of a few thousand years, the likely distance to the nearest civilizations detectable by SETI is of the order of a few thousand light years. The probability of detecting intelligent signals with present and future radio telescopes is calculated as a function of the Drake parameters.

Preparing to defend our home – EARTH

Harel Ben-Ami
ISA delegate for SMPAG Subcommittee, COPUOS, UNOOSA
harelbenami@gmail.com

Near Earth Objects (NEOs) constitute danger on regional and global scales. In the Chelyabinsk event in February 2013 an asteroid exploded at a few dozen kilometers altitude and caused over 1,000 casualties. The event clarified more than ever, the necessity for a world consolidation against the threat. In February 2013 the UN Office for Outer Space Affairs (UNOOSA) subcommittee convened and recommended the establishment of Space Mission Planning Advisory Group (SMPAG), which pronounced 'SAME PAGE' to emphasize that in this respect we are all on the "same page". SMPAG is an international group who will coordinate the human-kind preparations for the NEOs threat. The purpose of SMPAG is to prepare for an international response to a NEO impact threat through the exchange of information, development of options for collaborative research and mission opportunities, and NEO threat mitigation planning activities. During 2014 the Israel Space Agency (ISA) decided to join the international efforts to save lives in Israel and abroad in coordination with SMPAG, and in February 2015 Israel was officially accepted to SMPAG. The lecture will describe the current status of SMPAG and its initial working plan. In addition, I will deal with new ideas and concepts regarding Israel's ability to help the global effort.

Near-Earth Asteroids (NEAs) – Delivering Space Material to Earth

David Polishook
Weizmann Institute of Science, Rehovot
david.polishook@weizmann.ac.il

Asteroids orbiting the sun in near-Earth trajectories impact the Earth and deliver to it rocks, metals and volatiles from space. The composition distribution of NEAs, as derived from spectroscopic observations, shows that the ratio between rocky to carbonaceous asteroids are about 2:1. Dynamical studies of NEAs orbital evolution show multiple paths for a main belt asteroid (MBA), or an asteroid originated from beyond the snow line, to change its course and become a NEA. These include gravitational resonances and thermal recoil that can make an asteroid a NEA in a million years – very short compared to the solar system

age. Current studies are trying to tie NEAs to their original forming areas in the main belt or beyond the snow line in order to clearly draw the history and evolution of the solar system. In addition, the physical structure of NEAs is debatable since they do not seem to be strength-less as MBAs. This suggests that the small-ג sized NEAs are monolithic bodies compared to the large - sized MBAs that are more shattered, broken, conglomerates of rocks, known as “rubble piles”. However, the regolith dust within NEAs can serve as excellent “glue” due to its high frictional parameters, therefore, strengthening the “rubble pile” structure, making it almost as strong as monolithic bodies. The structure of asteroid is relevant since a rocky asteroid with a “rubble pile” structure can deliver to Earth carbonaceous material and volatiles compared to a monolithic rocky body.

Near-Earth Asteroids, Impacts, and How to Mitigate Them

Noah Brosch
Tel-Aviv University
noah@wise.tau.ac.il

In the recent past we have been informed that (a) the dinosaurs became extinct because a 10-km asteroid impacted the Gulf of Mexico some 65 Myr ago, and (b) that a meteor exploding over Chelyabinsk in 2013 caused 1000s of casualties; there is a factor of 500 between the sizes of these two bodies. The space agencies and the UN are finally taking notice of a possibility raised decades ago by planetary scientists. In this talk I will explain what the dangers are and what odds are estimated for different types of events. I will review existing and foreseen methods of mitigating probable impacts, and will specifically address the place of Israel in this global effort. I will emphasize the necessity of a very early warning system, the lack of suitable interceptors/deflectors, and the non-existence of political will combined with legal obstacles to develop and deploy such systems. I will stress the lucky preparedness of Israel for such events, given its perpetual conflict status.

How to Feed an Inanimate Evolvable Chemical System so as to Let it Self-Evolve into Increased Complexity and Life-Like Behaviour

Peter Strazewski
University of Lyon, France
strazewski@univ-lyon1.fr

We are beginning to explore a fully synthetic chemical micro-compartmented and evolvable macromolecular system being ‘fed’ with ‘monomers’ and small molecular weight, high energy compounds, to keep the system permanently out of thermodynamic equilibrium, and thus let it self-evolve into increasingly higher complexity. The initial compounds are giant vesicles composed of different lipidic amphiphiles, synthetic nucleic acids (predominantly synthetic RNA and DNA), synthetic peptides (predominantly made up from added amino acids) and synthetic carbohydrates (often chemically linked to lipids or peptides). While being furnished with more lipid amphiphiles, those giant vesicles that bear the most useful evolved features are expected to gain in population size through serial grow-and-divide self-selection cycles.

Composomics: a Common Biotic Thread

Doron Lancet
Weizmann Institute of Science, Rehovot
doron.lancet@weizmann.ac.il

Life's origin is about how sufficient chemical complexity emerged on early earth to afford replication. The graded autocatalysis replication domain (GARD) model (1), in the realm of the lipid world scenario (2), offers a novel route for these events, presumed to have taken place much before the advent of complex biopolymers, such as RNA. In this framework, non-covalent assemblies of diverse amphiphiles, e.g. multi-component lipid micelles or vesicles, can acquire adequate endogenous complexity and harbor considerable inter-assembly variation. Our computer simulations show that GARD assemblies carry and transmit compositional information through homeostatic growth, mediated by a set of catalyzed chemical reactions akin to metabolism followed by random fission. Key in GARD dynamics are composomes, spontaneously-forming replication-prone states emerging through compositional dynamics. We have recently demonstrated that composome populations resemble the much-studied RNA quasispecies (4). We further showed that such GARD species display a significant measure of Darwinian selection and evolution, particularly when their catalytic networks are enriched in mutual-catalysis as opposed to self-catalysis (3). Finally, we found that composome populations portray ecological dynamics that fit the logistic equation, often used to analyze species transitions (3). Thus, the GARD formalism allows one to outline a well-defined chemically-rigorous path from random chemical environments ("primordial soup") to replicating and evolving protocellular structures, without a prerequisite appearance of RNA-like catalytic replicators. Future GARD studies will seek a quantitative delineation of the transition from compositional information to polymer-based sequence-based information, thus supporting the concept of metabolism as a precursor for RNA world. In this realm, we pursue the idea that a present-day living cell is a very elaborate compositional assembly, whereby well-orchestrated compositions of RNAs, proteins, lipids and metabolites define its identity. Thus, "composomics" is a term that unifies transcriptomics, proteomics, lipidomics and metabolomics, forming a bridge between a hypothesized prebiotic emergence path and the fully evolved present day cellular life.

1. Segre D, Ben-Eli D, Lancet D, Compositional genomes: Prebiotic information transfer in mutually catalytic noncovalent assemblies. Proc Natl Acad Sci USA 97 (8):4112-4117 (2000).

2. Segré D, Ben-Eli D, Deamer DW, Lancet D, The lipid world. Origins of Life and Evolution of the Biosphere 31 (1-2):119-145 (2001).
3. Markovitch O, Lancet D, Excess Mutual Catalysis Is Required for Effective Evolvability. Artif Life 18 (3):243-266 (2012).
4. Gross R, Fouxon I, Lancet D, Markovitch O, Quasispecies in population of compositional assemblies BMC Evol Biol. 2014 Dec 30;14(1):2623.

The impact of scientists' philosophical and political-ideological views on their research related to the origin of life, 19th and 20th centuries

Ute Deichmann
Jacques Loeb Centre for the History and Philosophy of the Life Sciences
Ben-Gurion University of the Negev, Beer Sheva
uted@bgu.ac.il

Philosophical and political-ideological views strongly impacted scientists' research on the origin of life and the synthesis of life in the laboratory. These views included - on the one hand - materialism, beliefs in the fluidity of life processes and the central role of self-organization of matter - and on the other - the emphasis on sharp differences between forms of life, their constancy of time, and the central role of genetic information. I will analyze the impact of these views on three controversies related to the origin of life, 1860 - 1960.

Bistability and Bifurcation in Reversible Catalysis

Rakesh Mukherjee, Nathaniel Wagner, Gonen Ashkenasy
Department of Chemistry, Ben Gurion University of the Negev, Beer Sheva
rmukherjee3@gmail.com

Chemical systems with catalytic features sometimes can rise to interesting behaviors like oscillations, spatio-temporal patterns and bifurcations owing to their non-linear dynamics. Till date, there have been quite a few reports of nonlinear behavior of the systems, though the underlying mechanisms are not yet well-understood. We, thereby, intend to utilize the group's expertize on peptide chemistry to probe into the nonlinear dynamics of peptide based reversible autocatalytic replication systems. In our lab, we have exploited α-helical peptides[1] and thioester-based depsipeptides[2,3] in order to demonstrate dynamic behavior under kinetic and partial thermodynamic drives. Thus, to exhibit the nonlinear

behavior in a comparatively simpler reaction, current research focus has been directed towards novel peptide based systems.

We herein demonstrate the nonlinear dynamics of a closed reversible single-replicator system towards equilibrium. Simulation studies in our group using realistic experimental data have suggested that bistability exists in a closed autocatalytic system for particular concentration regimes. Thus, to find out the validity of the proposed model, an experimental approach has been taken where peptides capable of forming and breaking reversible thioester bond have been allowed to equilibrate. Our experiments deal with a simplistic system made of two peptides, electrophilic thioester fragment E1 and nucleophilic fragment N1, which can form a reversible thioester bond when subjected to appropriate condition and generate R1, a thiodepsipeptide. R1 can dissociate in presence of a proper thiol to regenerate E1 and N1. A dimeric form of the product R1 serves here as an auto-catalyst which introduces nonlinear behavior in the system. The results showed that for the same total concentration, different initial reaction conditions for a reversible peptide replicating system results in bistability, i.e. they reach distinctly different steady state concentrations depending on their history.

1. Eisenberg, M.; Shumacher, I.; Cohen-Luria, R.; Ashkenasy, G. Bioorg. Med. Chem. 2013, 21, 3450.
2. Dadon, Z.; Samiappan, M.; Shahar, A.; Zarivach, R.; Ashkenasy, G. Angew. Chem. Int. Ed. 2013, 52, 9944.
3. Dadon, Z.; Wagner, N.; Alasibi, S.; Samiappan, M.; Mukherjee, R.; Ashkenasy, G. Chem. Eur. J. 2015, 21, 648.

Hypothesis: Network of RNAs and their Influence on Life

Sohan Jheeta
Chairman: NoR HGT & LUCA, 1 Scott Hall Crescent, Leeds LS7 3RB, UK
Sohan7@ntlworld.com

The continued unearthing of new roles for RNAs in the form of activities pertaining to the non-coding portions of DNA, is testified to by a spate of discoveries – for example snoRNAs, microRNAs, siRNAs, snRNAs, exRNAs, piRNAs, Xist, HOTAIR and spliceosomes. Such RNAs, in general, are involved in a vast number of processes from DNA replication (in the form of primer requirements), coding, decoding, code translation, peptide bond formation, ribozymatic activities; control of gene expressions, cellular defence against invading mobile genetic elements and even self-processing. This warrants a new postulation that the overall control of cellular life forms may well reside in a 'network of RNAs', whilst the informational genetic code necessary for life's perpetuation still rests with DNA. Nevertheless these RNA networks would be passed on from one generation to the next. It should not go unnoticed that RNA's full activity within a cell is masked by an overwhelming presence of a vast diversity of proteins and the fact that we have not been able to assign a full role to the remaining non-coding DNAs. To this effect it is now becoming clear that there are no such things as 'junk' nucleic acids; everything in the cell has a part to play and is sooner or later utilised. In this presentation I shall highlight RNA's influence on life on Earth and suggest how the role of RNA can be tested in favour of cellular life forms being organised and controlled by RNA/protein.

When Physics Met Information - a Model for the Emergence of Coded Life

Ilana Agmon[a,b], Yuval Elias[c], **Tal Mor**[c]
a Schulich Faculty of Chemistry, Technion, Haifa
b Fritz Haber Research Center for Molecular Dynamics, Hebrew University of Jerusalem
c Department of Computer Science, Technion, Haifa
talmo@cs.technion.ac.il

In the conceptualization presented here, a possible scenario concerned with the emergence of coded life in nature is inferred from a model that merges computer science and information concepts with prebiotic chemistry. In this model, sets of strings composed of letters, such that each letter represents a molecular building block, are located within compartments. Some of the sets of strings (together with their reactions) form "autocatalytic sets". Some of the strings in the autocatalytic sets play the role of catalysts of reactions and others play the role of templates for replication processes. Several autocatalytic sets are presented, that evolve without leading to the formation of a code. However, a unique set of strings, comprised of two types of letters (representing nucleotides and amino acids), with some inherent asymmetry in their properties, is found to prompt the emergence and the fixation of a code. By identifying "code prompting" autocatalytic sets, our abstract model suggests a possible explanation for the emergence of the genetic code in life as we know it.

- Nathaniel Wagner (BGU) Opening Remarks
- Terence Kee (Leeds, UK) Towards Convergent Abiogenic Processes
- Malcolm E. Schrader (HUJI) Punctuated Equilibria in Geobiological Evolution
- Addy Pross (BGU) Evolutionary Dynamics in the 'Regular' and 'Replicative' Worlds: Boltzmann vs. Malthus
- Ehud Meron (BGU) Surviving Stress by Pattern Formation
- Eyal Arbely (BGU) An Expanded Genetic Code
- Prof. Jiwchar Ganor, Dean of the Faculty of Natural Sciences (BGU) Greetings

- Pierre-Alain Monnard (SDU, Denmark) Protocells: Laboratory Models for the Emergence of Living Cells?
- Amri Wandel (HUJI) On the Abundance of Exo-Life after Kepler
- Joseph Gale (HUJI) Quo Vadis Astrobiology?
- Danny Portman (Technion) Adaptable Habitability
- Hagai Perets (Technion) The Origins of Earth's Previous Moons, and Why is the Moon Made Out of Cheese?
- Sivan Ginzburg (HUJI) Hot-Jupiter Inflation due to Deep Energy Deposition
- Harel Ben-Ami (COPUOS, UNOOSA) Preparing to defend our home - Earth
- David Polishook (WIS) Near-Earth Asteroids (NEAs) – Delivering Space Material to Earth
- Noah Brosch (TAU) Near-Earth Asteroids, Impacts, and How to Mitigate Them
- Peter Strazewski (Lyon, France) How to Feed an Inanimate Evolvable Chemical System so as to Let it Self-Evolve into Increased Complexity and Life-Like Behaviour
- Ute Deichmann (BGU) The Impact of Scientists' Philosophical and Political-Ideological Views on their Research Related to the Origin of Life
- Rakesh Mukherjee (BGU) Bistability and Bifurcation in Reversible Catalysis
- Sohan Jheeta (NoR HGT, LUCA) Hypothesis: Network of RNAs and their Influence on Life
- Tal Mor (Technion) When Physics Met Information - a Model for the Emergence of Coded Life
- Gonen Ashkenasy (BGU) Closing Remarks