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Message 2/16 From Louis H Kauffman: kauffman@uic.edu
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Dear Roy,

I was amused to read about a certain fictional character bearing my name in your last issue of Ferment. It was strange to encounter a character with my name who had so few traits in common with myself! For example your character apparently was always falling asleep in mathematical physics lectures, needing the help of a Lisker (a well known stimulant) to stay awake. Of course everyone knows that I am right on the edge of my seat in a lecture of that sort. Ready to pounce! The truth is quite the opposite. You were the one who fell asleep, because you've obviously dreamed up everything that you think happened at the conference! Then your character was seen carousing in a bar at some University Club with a group of disreputables. You know that I only drink iced tea and never engage in controversy. Most curious. A curious coincidence that your character bore my name and was also a mathematician. The conference itself was a most interesting
invention. But who, among your readers, will believe that a large group of people would get together over a weekend to discuss holes in the fabric of space and time. Preposterous really. Of course you are depicting an extreme of Ironic Science that is beyond the conception of even the most advanced journalists in Scientific American. For this I congratulate you!
Yours truly,   Louis H. Kauffman

Symposium in Honor of S. Chandrasekar
The University of Chicago
December 13-15, 1996

Part II: The Cosmologists:

The Frame-Invariant Moveable Feast

Coming up the staircase, I counted three dining- rooms on the second floor of the Quadrangle Club . The architect had taken a page from Escher : the enclosures are regulated by pillars, casements and balustrades in such a way that the assemblage might, and did, move freely between all of them. Flitting from table to table, absorbing and transmitting gossip, one took notice of a stocky , vivacious redhead - Yuval Ne'man's wife .

The menu of the symposium of the Symposium was South Indian, compiled from recipes that Subramanyan Chandrasekar had often prepared for friends. Kameshwar C. Wali, in his biography "Chandra", tells us that his residence in the West for most of his career had obliged him to become his own cook. The fare was vegetarian: rasam soup, lentil pastes such as dahl, vegetable masalas, rice, yogurt sauce, dates and mangos, breads such as poori, chapattis and papadam, and the Indian candies known as jelebis.

Lou entered the largest room and led me to a group of tables furthest at the far wall. The astrophysicist , Kip Thorne, a man of impish wit, exuberant with Southern California health, immaculately groomed, in whose manicured van Dyke beard streaks of black and white hair commingled like a random distribution of black holes and white dwarfs, was already seated there. Next

to him sat Ed Witten, the mathematician and physicist. Witten has an elongated skull on which is painted an intense and sardonic face, thick spectacles, a suit such as might be worn by a applicant desperate for some civil service position , and, it must not be forgotten, an aura of brilliant intelligence that hits you between the eyes like a cinema spotlight the moment you step into his neighborhood. To the left at an adjacent table sat observational cosmologist Martin Rees, scruffy, thin, over-worked and defensive, and, next to him, the cyber-chair of Stephen Hawking, who needs no description, together with his wife and other members of his circle.

A   table behind ours, closer to the center of the room yet within ear-and-eyeshot, held John Archibald Wheeler, Rafael Sorkin, and Valerie Ferrari. The elderly Wheeler is large, hunched-over , sedentary, erudite and self-composed, a man with enough imagination for 3 and rhetoric for 5, an extremely courteous and generous human being , which some people, myself among them, find difficult to square with the fact that he was the director of the hydrogen bomb project in the 50's : the attributes of human beings are rarely as consistent as those as electrons, black holes or quarks. The austere young quantumist Sorkin   is best described as taciturn: I'd the impression that he spoke when, and only when, he had something to say, an admirable gift which neither I, nor most of the people I know, possess. Otherwise stated,

although both Wheeler and Sorkin work with space-time quanta known as 'geons', their linguistic   profiles are in polar opposition.

The   charming and reserved Italian astrophysicist Valerie Ferrari had been a mathematical assistant to Chandrasekar in the last years of his life. She was also the lone female speaker at this painfully masculinist event. Science remains politically regressive: its action is never more affirmative than those who pay the bills. Lou Kauffman sat down beside Ed Witten to his right, myself on his left . Fortunately for them , (and the rest of us) , a certain Herr Dr. Professor Gerhardt Schneider, a physics professor from some small college in Germany, not registering the repelling force fields of renown surrounding them , interposed himself between them then prevailed upon Lou to deliver an impromptu lecture on the connections between knot theory and statistical mechanics. It's Lou's Achilles   heel: anyone can immediately command his time and attention by requesting illumination on this topic.

This put me next to Kip Thorne. I mentioned a letter I'd written him after reading his very good book on relativistic stars, the semi- popular Black holes and Time Warps . He excused himself; he rarely found time to answer letters. In my most apologetic manner I reminded him that, on his Internet homepage, (which anyone can look up through Lycos or equivalent search-engines) , he requests that people who want to contact him should write to him directly, and not use his E-Mail

address . He acknowledged this as a valid point, then pointed out that his homepage did not indicate that he would bother answering such letters - from which I surmised that he didn't have much time to waste talking to small fry like me.

Roger Penrose turned out to be much more approachable. He had stopped at Hawking's table to chat for about 15 minutes before coming over to join us. Penrose is alert, courteous and voraciously curious, qualities which also come through in his writings. He does not try to impose his ideas on you, which does not mean that he is any less tenacious or obstinate in holding them: perhaps he holds more stubbornly fixed ideas per milliparsec than any other famous mathematician turned cosmologist turned popular expositor turned prophet; which doesn't diminish their interest.

We'd spoken once before: at the 11th General Relativity and Gravitation conference in Stockholm in 1986 he'd sold me a hardback copy of the second volume of his densely massive treatise, co-authored with Wolfgang Rindler, on spinors and twistors (1). He remembered the transaction: It was the last of the copies he'd brought with him to the conference, and he let it go for 30 pounds .

" Yours was the only book I bought at the conference." , I remarked, " I put it on my expense account."

Lou stopped his lecture to Schneider in mid-stream, turned around and squinted at me suspiciously : "Roy-when did you ever have an expense account?'

"Quiet, Lou. I'm trying to impress Penrose."

" All right: but given that you never read the book , why and how did you pay for it ?"

"How do you know I didn't read it?"

"With all due apologies to Roger, all textbooks on current research are unreadable."

"Well Lou , you're right. I tried to read it but couldn't, even though I'd learned spinor theory from other sources ."

Penrose agreed: " Professionals really learn their subjects at conferences like this one. There's nothing to be ashamed of, Dr. Lisker . What happened to the book ?"

" I sold it to a theoretical physicist at the State University of New York at Albany for $20 . Three years later I re-discovered it on the shelves of the second-hand bookstore, the Strand, on New York's Lower East Side, going for $5. I knew it was mine, because Roger's signature and the date were in it."

"Dr. Lisker", Penrose beamed, "why do you think I was so eager to get the book off my hands ? The hard cover version is sold to libraries and specialists ; once the publishers bring out the paperback edition for classroom

use, the remaining hardcovers become worthless. They're often bought right off the warehouse floor by one on those science book clubs, for, say, $1.00 a copy, then advertised to their members at the incredibly low price of $25! I just took you for a gull, you understand." We all laughed:

" Well, Dr. Penrose, I didn't actually pay for the book. A personal friend, a Dutch physicist put them on his expense account. Ultimately the Dutch government paid for it. "

" Oh- is that so? " Lou crowed " Have you since done nothing to acquit your obligation to the legally appointed authorities of the Netherlands, guardians of the will of the Dutch people ! ?"

After a moment's reflection, I replied : " Of course I did, Lou : in 1988 I set a detective story in Eindhoven."

During our conversation , Martin Rees and Valerie Ferrari had started a shouting match between their tables and over our heads . Rees wanted to know more about 'quasi-normal modes', the topic of her lecture that morning .

"How would you describe a quasi-normal mode without using lots of mathematics?" Rees asked.

Valerie Ferrari stood up. Holding an empty crystal goblet in one hand, she struck it sharply with a fork.

John Archibald Wheeler clapped: " Right-ho! Well done!" Beating the goblet in time, she danced a quick tarantella about the floor.

"When you strike a bell with a hammer", she explained, "the final tones emitted just before the sound dies away completely are the resonant frequencies of the hammer. The quasi-normal modes are, in a sense,   the pure bell tones emitted by the Black hole during the last stage of its formation by gravitational collapse."

"The musical image is Chandrasekar's, isn't it?" Penrose observed.

Valerie Ferrari didn't know, but I did :

"Yes: it shows the influence of his father, C.S. Ayyar, a noted musicologist and performer of Karnatic music."

Rees turned away from Ferrari and began shouting at Ed Witten across the chests of Lou and Gerhardt Schneider, with the result that they could barely hear one another. Synchronically Witten began shouting at Lou across Schneider's chest , while Lou was shouting something at Penrose across mine. Similar conversational conduct was spontaneously erupting through all the rooms; it is a commonplace of all science conferences.

Rees   wanted Witten to explain more to him about his current thinking on 'string duality' which, he had claimed, might be used in the detection of black holes. Witten paused long enough from haranguing Lou to explain :" We've really invented a new kind of statistical mechanics; we may in fact have re- invented all of science - maybe that's too ambitious - but it's undeniably

true that string duality, or 'stringy geometry' is the first major advance in our understanding of space since Euclid. Devices we call p-branes and m-branes will give us particle counts for the stuff going in and out of black holes."

" Coupled axial and polar quasi-normal modes might be more sensible ! " Ferrari yelled to Witten. Her words sailing over Lou's head prompted him to turn around and address her :

" Yours' was the first talk this morning. Thanks to my colleague, Dr. Lisker over here, I must have fallen asleep. " His eyes , smoldering with the mental calculation of the amount of money he'd thrown away for my services, glared me down, "but what are quasi-normal modes?"

Ferrari did a pirouette and once again banged several times on her crystal glass. Now a waiter came weaving through the tables to present her with an exquisite little hand- held temple bell from Trivandrum. Handing over the glass and fork, she took the bell and asked: " Where did this come from ?" The waiter indicated Lalitha, Chandrasekar's widow, smiling at her and waving from a far corner of the room.

" Well, Dr. Kauffman ", she said, tinkling the bell with a gentle motion. "Here's a jingle for you." She began:

"A quasi-normal mode
is very like a bell,
That ever jangles sweetly out of tune;
As if through vacuum flowed
The Chaconne of Pachebel
From throats of guard-dogs baying at the moon!"

Lou subjected this to careful consideration: "Okay-but that doesn't convey the essence of the object , not to a mathematician. Can you tell me what the equations look like?"

"Sure! The Schwarzschild metric looks like this: "

Taking a militant stance, with hands on hips, she bellowed:

" d′ s′ squared e′quals e′ to the 2′ nu′ (!) , times′ d′ t′ squared′ , minus e′ to the 2′ myu′ sub two′ (!) ,times′ d′ r′ squared′ , minus e′ to the 2′ myu′ sub 3′ (!) , times′ d′ q′ squared′ , minus e′ to the 2′ lam′bda (!) , times′ the quan′tity paren′thesis , d′ phi′ minus ome′ga d′ t′ , minus q′ sub 2′ d′ r′, minus q′ sub 3′ d′ the′ta , end of paren′ thesis (!) squared (!)   Have you got that?”

"That's more like it.” Lou replied, with evident gratification, “ I notice you've got a lot of Greek letters for exponents, and also some angle letters, I assume they're angles, and a number of q's with indices attached to them, (not to be confused with q-deformations in quantum algebras) , all adding up in some way that remains as yet unspecified into something on the left side which looks like a length measurement, so I'm assuming that this is some

kind of fundamental equation of the metric that you're going to separate into various components, that will exhibit different kinds of behavior depending on the way perturbations act individually or together on the respective quasi-autonomous groupings of symbols. I'm not all that comfortable with equations anymore; whenever possible I replace them by elaborate drawings filled with boxes, nodes, branches and odd squiggles that I can manipulate according to algorithms on diagrams , graph deformations, vertex operators, bracketings and so on. Is that right?"

" More or less: axial perturbations, those of the parameters w, q2 and q3 , do not affect the basic form of the metric, and are theoretically manifested in space-time as pulsations of the black hole ; perturbations of the parameters n , m2 , m3 and g , do affect the metric, producing the

phenomenon known as the 'dragging of reference frames'.

" If I might suggest a reformulation " , Penrose interposed , " Once you situate the singularities on the boundary of space-time, they become more fundamental than the metric : physically, you ought to be able to get the perturbations of the metric right out of the pulsations of the black hole."

"Chandra made that observation", Ferrari explained, "The coupling of axial and polar perturbations is a consequence of General Relativity. It's absent in the classical theory."

" Of course!', I shouted: " it all ties in with my conception of the 4-fold dualities of quantum gravity!" Everyone ignored me.

 Penrose went on:

 " I've no objections to quasi-normal modes. They're not inconsistent with cosmic censorship and may even reinforce the necessary requirement for an arrow of time."

"There he goes again", Thorne wryly commented, stroking his van Dyke " Anything is grist for Roger's mill, as long as it forbids wormholes. Roger, I'll lay you a bet of $500 , a tee shirt, and two tickets to Deep Throat , that within the next century we're not only going to find wormholes, we're going to manufacture them! If I'm not around my heirs can collect . "

Penrose's taut, dark eyes flashed in mock amazement:

" But Kip? You're coming back, aren't you? You must be manufacturing your own traversible wormhole right now in the labs at CalTech!"

From the adjacent table Stephen Hawking's computer played back a pre-recorded message: " Not Deep Throat , Kip! : Nature abhors a naked singularity! "

"So tell us, Roger", Thorne went on, "Why are you against wormholes?"

" I'm not against wormholes , provided they're not traversible. If a black hole gets sucked into one of your wormholes, then it has to come out as a white hole. A white hole is a time-reversed black hole - parenthetically,

Valerie, your quasi-normal modes would also come out time-reversed. I haven't looked at the mathematics, it's all beautifully presented in Chandra's book, but I suspect that time-reversed quasi-normal modes wouldn't sound like anything."

" That's interesting ", Rees commented, " You might call it a music of the spheres argument - time-reversing Beethoven's 5th and getting nothing."

" C. S. Ayyar would have approved." I remarked, " He accused his son of being a calculating animal. He would have been happy to learn of a situation in which the music ultimately defeats the mathematics."

"Anyway" Penrose persisted, " white holes are forbidden by the work of Hawking and myself. No white holes, therefore no stable wormholes. It's all above board to go from gravitational collapse, (which is a deterministic correlate of general relativity) , to evaporation, which is a quantum, therefore stochastic phenomenon ; but I can't see any way one can go in the reverse direction and get white holes , unless you can show me how to derive the laws of general relativity from quantum theory! "

" Maybe", Rees broke in , " but don't you think we ought first to find out if black holes really exist? By the way, I prefer to call them 'super-massive stellar objects', because there are 8 good candidates for those, but they may not ultimately fit the picture we've drawn of a black hole ."

From the other table we could hear the sounds of Hawking banging on a plate with a spoon.

Thorne laughed uneasily, much as one might do at a meeting of the Communist Party after hearing a fellow traveler announce that he didn't subscribe to the labor theory of value:

"Hey, Martin! Come off it : this isn't 1928! Black holes have to exist! The delicious atmosphere of total make-believe that I've lived in for my entire career, has been founded on the absurd over-simplicity of the black hole concept. I'm not about to give that up! "

"Don't you realize, Martin," Penrose added, " that all solutions of the equations of general relativity in a finite non-rotating universe have to have singularities? Stephen and I proved that in 1965."

"You can talk equations as much as you like", Rees countered, "but you yourself had to invoke cosmic censorship to keep the universe from falling into chaos. My view is that nature doesn't like singularities anymore than it does vacua ."

Thorne raised up his large frame and waved his hands with exasperation: " Black holes are like Absolute Goodness: even Christ wasn't as perfect as a black hole! Look at all those Renaissance

paintings; he had lots of hair! Black holes have no hair! Imagining what goes on inside black holes is more fun than Star Trek! Chandrasekar himself liked black holes because they're so pretty. It has no hair , it's in the air, it's completely bare! All of its characteristics are completely specified by 3 parameters, mass, electromagnetic charge, and angular momentum ! Who could ask for anything more? "

Everybody else was shouting across the chests of their immediate neighbor , so why shouldn't I do the same? "Well, if you ask me!" I yelled, " that's why we'll never see them!"

Thorne pointedly ignored me, but Rees was interested in what I had to say, so I turned around to him and explained:

"If Black holes are so clean, our instruments won't be able to see them. Billions of numbers do not suffice to describe the materials used to build even the smallest telescope, but the things you want to see with them need only 3 numbers for their description . Imagine trying to study a star through a telescope with lenses and mirrors covered with 200 tons of caked mud!"

Rees watched me with absorbing interest. After I'd finished unloading this weighty observation, he remarked : " I know you from somewhere, don't I?"

I assumed a manner together mysterious and omniscient : " You probably don't remember where we last met ."

" I'm afraid not. It was quite some time ago, wasn't it?"

" Well, I'll tell you. I was in the audience during the Einstein Centennial Symposium in March of 1979 when you delivered a paper on the isotropy of the universe. I asked a question that disconcerted you."

Wagging a finger at me, Rees' face broke out into a broad smile: " Aha! You're the one!" He reached over and we shook hands. " I tried to find out who you were; nobody had heard of you."

"Yes, I remember. You even bumped me on the stairs. You almost knocked me down."

" Sorry about that; you got me upset. I put a friend onto your trail : You told him you were a philosopher of science at Columbia University. Are you still there?"

"No. I became embroiled in a tenure dispute with the university in the 1980's. I ended up suing them. They paid me a large out-of-court settlement but as part of the agreement I left Columbia. Best thing that ever happened to me. I was a bio-ethicist at Roosevelt Hospital for awhile. Then I spent a few years in Austin, Texas and the University of Wisconsin. Around 1986 I started working for a cosmological think tank in Ventura, California, funded by a rich eccentric who made his millions in napalm research. I became its director in 1993."

"What's its name?"

"That was recently changed; its new name is the Ventura Auxiliary Logocenter for the Investigation of Universe Models ."

Together with my name, Martin Rees carefully wrote down its initials , address, phone number E-mail address .

" Does it have a publication?"

"Yes it does: Ferment . I'll send you a copy."

"Thank you. Well, Dr. Lisker, you gave me quite a fright at the Einstein Symposium. If I remember correctly,   you said something like the following: Cosmologists have a convenient way of explaining everything: if they see uniformity in the cosmos, they invoke the principle of isotropy; if they see randomness or chaos, they appeal to the Big Bang.'"

"That's exactly what I did say; and the organizers at the Institute for Advanced Study didn't know how to handle the situation, because I got into the Symposium by telling them that I was a staff journalist for some magazine whose name I'd come up with on the spur of the moment, and here I was asking questions in an auditorium reeling with Nobel prize winners. But it was a good question, wasn't it?"

"It was an excellent question, and I'm still working out the consequences."

Rees and I were soon embroiled in conversation. Lou Kauffman was showing Ed Witten some knot tricks with a piece of rope he always carries

about his pants pockets. Penrose and Thorne continued to argue about the feasibility of time-travel.

"Roger", Thorne began, " After I read 'The Emperor's New Mind", I realized that you had pulled off the public mystification feat of the century. You swept", he ticked off the items on his fingers, " (1) black holes, (2) statistical mechanics, (3) cosmic censorship, (4) your Weyl Curvature Hypothesis, (5) the graviton, (6) the collapse of the wave-packet, (7) the 2nd Law of Thermodynamics, and (8) the arrow of time, all under the same rug! Can you give me one good reason why your magic graviton makes more sense than my time-reversing traversible wormholes?"

"Actually, Kip, I prefer to speak of gravitational entropy- but our friend Abby Ashtekar sitting at the other end of the room has convinced me that I'm really talking about graviton particles. One of the strong points of these gravitons is that you can't detect them: they slide in there below the Planck length which, by definition, is smaller than anything anyone can see. But unless you're in a lunatic asylum, you can't possibly deny that time marches on in the forward direction."

"Nowadays", I remarked dourly, "they give them Valium and put them out on the sidewalks!"

"You're a damn Platonist! ", Thorne swore, "You're worse than that: You believe in retribution for sin, just like my Mormon ancestors. You want evil

people to go to Hell when they die ! You refuse to acknowledge the priceless option traversible wormholes offer to the world : Salvation! I've uncovered a cure for persons crushed with guilt: Time-Travel! Mankind may at last have the chance of going back and correcting all its' wrong-doing!"

Penrose turned his chair towards the wall, leaned back in his chair and laid his hand over his mouth and chin: " You've thrown lots of issues at me, Kip. I have to think about that." After another ten minutes and some hastily scribbled calculations he turned around again:

"Well I guess I am all those things: I can't imagine that the universe would allow for something like causal breakdown, although it comes out of Einstein's equations, which means that you've got to have some form of cosmic censorship. It's also true that even though the arrow of time is one of primary givens of experience, you won't find any evidence for it in any of the equations of physics, (except perhaps in Thermodynamics, where you're really playing with words: time is defined as the direction of increasing entropy: Steve 's done some cute stuff with that.)

But then again : why is the origin of the universe so improbable?   W hy is the entropy of the initial conditions so low? I don't have much faith in String Theories , or Anthropic Principles, or Inflationary Cosmology , because they don't explain why something with an entropy as low as the 2nd Law of

Thermodynamics, that is to say, the law of entropy itself , could ever come into existence."

"The law of the entropy of the law of entropy", Witten mused

"The law of the entropy of the law of the entropy of the law of the entropy !" John Archibald Wheeler chimed in.

Valerie Ferrari picked up her temple bell and waltzed about the room, chanting "The law of the entropy of the law of the entropy of the law of the entropy..."

Her example was infectious. Suddenly people at every table were clinking knives and forks against plates and glasses and chanting: "THE LAW OF THE ENTROPY OF THE LAW OF THE ENTROPY OF THE LAW OF THE ENTROPY OF THE LAW OF THE ENTROPY....",

while next to the table where Lalitha Chandrasekar, Kameshwar C. Wali and Hugo Sonnenschein were seated together, cross-legged musicians on a raised dais struck up a lively accompaniment on sitar, flute and tabla, in triptala and the raga Vesant-Bihar!

"Basically I'm an old fashioned determinist!" Penrose cried out above the musical background: " I guess I do see God the Law-Giver out there, searching for the right place to puncture the cosmic balloon. Neither inflationary cosmology nor string theories can begin to explain why we live in

a universe whose laws are less probable than one part in 10 to the 10 to the 123rd! "

To which Martin Rees wryly commented : "Why bother to ask where oxygen comes from, since we wouldn't be alive to ask the question if it wasn't here?"

"All right, Martin", Penrose conceded the point, "I'm no more an advocate of Theogenesis than I am of Anthropism. But Kip, I still wonder why you're so fond of wormholes. "

It was Thorne's turn to laugh : "Well, Roger, I became hooked on science fiction at an early age. Science fiction and time travel go together like frogs and princesses. Carl Sagan wanted some kind of plausible gimmick for one of his novels....But Steve Hawking over at the next table is the resident expert on wormholes; why don't you ask him?"

Hawking had been listening to our conversation and began working the buttons on his computer to transmit another sound byte:

" I created the theory of the "chronological projection" to prevent traversible wormholes: Can you imagine the consequences of   billions of tourists from the future descending upon us en masse?"

"Look, Steve", Thorne retorted, fired-up : "you stand to lose 100 pounds and a tee shirt if my ideas about time travel turn out to be feasible! Furthermore, my ideas happen to interfere with your Theory of Everything,

your so-called 'wave-equation of the universe' . But your theories invoke a concept of time in the square root of minus one dimension! How are my traversible wormholes any nuttier than your imaginary time dimension?"

"Ah!" Penrose beamed, "The square root of minus one!" Then, scooping up a serving of masala dosa with a chappati fragment , he added, " Kip, you can't mix up a Theory Of Everything with your traversible wormholes. A Theory Of Everything has to incorporate an arrow of time."

"So, Roger: you're saying that you   have a Theory Of Everything?"

"Everything Theorists are usually String Theory types, but I don't see why my Theory of Everything isn't just as good as theirs : The arrow of time, the graviton, the Weyl Curvature Hypothesis, and the collapse of the wave packet, expressed in the only formalism available for that purpose, the twistor calculus! "

" A far cry", Wheeler shouted across the room, " from my Geometrodynamics! For shame, Roger: there's no pre-geometry in your graviton! Where do the neutrinos come from?"

Thorne whispered to Penrose:

"Don't take what John says too seriously on that subject . He was the one who insisted on putting geometrodynamics in Chapter 44 of Gravitation , the humungous treatise that we wrote together with Charles Misner. We let him

do it because the chapter added just enough weight to make it the heaviest paperback in publishing history."

Martin Rees choked on a cracked papadum: "Every one of those things, Roger, is a vague abstraction; there's not a single thing in it you can pin down. I'm an observational cosmologist . The rest of you are only relativistic cosmologists, or quantum gravitationalists, or theoretical quantum cosmologists, or axiomatic quantum dynamists, or quantum field theorists, or string theorists, or knot theorists masquerading as string theorists , or, in the case of Dr. Lisker here, a bioethical cosmologist " , Rees scratched his head and regarded me curiously   " - I guess. There's not one real astronomer among the lot of you! You may all despise mere observations, but they're a marvelous corrective to having your head stuck in the Magellanic Clouds.   I've never seen a graviton, a geon, a geometrodynamic exciton, a gravitational electromagnetic entity, a naked singularity, a cosmic censor, a quasi-normal mode, a wimp, a wino, a macho, an anyon, a topological diquark,   a p-brane, an m-brane, a cosmic string, a heterotic string, a superstring, a pre-geometry, a stringy geometry, a space-time boundary, a twistor, an undressed electron, a white hole, even a black hole,   a collapsing wave packet, quantum foam, a wave function of the universe, an imaginary time dimension, or even something so simple and so theoretically well established as a gravity wave! The fact that I consider this important may strike all the rest of you as damn

pedestrian , but that's the way it is. This doesn't mean that these things don't

exist; in fact I've invested my entire career in looking for them!"

"What you're saying I gather, Dr. Rees," I commented, " is that there's a

lot of crap flying around up there, and the only way to begin to clean up the

mess is to find some of it."

Penrose beamed, "Well, Martin: you must admit that I'm closer to the

truth that our airy-minded younger colleague, Ed Witten. He thinks that

strings are the stuff of Everything. Let me show you what I think of strings! "

Penrose picked up a handful jelebi candies and kneaded them into the

shape of a two foot long cord. With a quick jerking motion of the wrist he

flipped it up to the ceiling where it rocked back and forth like a vacuum

fluctuation from the edge of a chandelier.

"Oh, is that so?" Witten roared, roused to anger at last, "Well! here's

what I think of your gravitons!" Witten sent half a dozen date pits flying over

Penrose's shoulder . One of them grazed John Archibald Wheeler on the side

of the head just as he was standing up. Wheeler picked it up ,turned around

to face Witten, and said :

" I'm too grown up to get involved in this debate. Thank goodness

you're not arguing about total nonsense like cosmic inflation. It ought to

obvious to a babe in swaddling clouts that the substance of Everything

consists of densely packed flecks of frothing quantum foam, borne on the

crests of Time's All-Sundering Wave!!" To emphasize his position, Wheeler held up a large inflated loaf of poori , squashed it between his hands , and threw it across the room.

" Thus to all inflationary scenarios!"

It appears that Wheeler's gesture had intersected , (in twistor space), with the local action of the universal DeBroglie Probability Wave, to produce a spontaneous symmetry breaking that rippled through the dining room like a space-time thunderbolt. Within seconds the genteel ambiance of the Quadrangle Club had degenerated to the arena of a free-for-all food fight between the world's weightiest intellects!

"Topological geons!" cried Rafael Sorkin, " Causal pre-sets!". As he said this he threw a bowl of rasam in the direction of our table: " The causal sets in the pre-geometry encode the arrow of time! Penrose's arrow will never fly! The point is blunt and the arrows are all wet! Geons! Geons!"

Lou Kauffman stood up and barked : " I think that all of you are tied up in knots! The basis of Everything is knotted strings! It's as clear as the nose on your face." Saying this, he dumped a plate of basmati rice in Witten's lap. NOT strings, Ed; KNOTTED strings! In particular, the KNOTS IN the strings, NOT the STRINGS themselves! The knots are organized within a grand underlying scheme called the NETWORK! The Network rules ALL ! NATURE, my friends , is the ULTIMATE CONSPIRACY!"

Roger Penrose stood up and swore lustily with many gesticulations: " All of you idiots who believe in time-travel should take a look at this!" He raised up a decanter filled with fruit juice, poured its contents on the tablecloth, then smashed it on the floor. With his left foot he broke up the larger pieces until it was reduced to a gravel heap.

" Okay, folks!", he shouted, " Make the glass come back again! Do it! Try and drink the orange juice! Has my point be proven? Long live the graviton! Long live the Weyl Curvature Hypothesis! Long live Cosmic Censorship! Long Live Everything!" Then Penrose started throwing knotted strings of jelebis about the room.

As plates and bowls and fistfuls of food went flying through the air, one could hear a commentary that went something like this:

" Rainich-Misner-Wheeler, you jackass!"

" No! No! Never! Ashtekar- Rovelli - Smolin!"

" You fool! You didn't apply the Pryce-Tani-Foldy-Wouthuysen transformation!!"

" I think one ought to take a look at the Noyes-Manthy-Gefwert discrimination!"

" Why? Don't you trust the Christodoulou- Hawking-Bekenstein computation?"

" Yes! But what about the Chern-Simons-Feynman-Jones-Witten invariant!"

" Don't be ridiculous! You can't reconcile that with Becchi-Rouet-Stora-Tyntin quantization!"

" Not even in a Nakanishi-Lautrup field? With Steukelberg formalism?"

" I solved that myself, thank you, without the help of the Hatcher-Thurston-Haher-Wajnryb Theorem!"

- along with other highly illuminating commentary of the same character.

It was deemed that the situation had gotten out of hand when Ed Witten threw a dishful of raita yogurt dressing at Hugo Sonnenschein, president of the University of Chicago. Sonnenschein threatened to deny them all travel grants unless they stopped carrying on . This had the desired effect.

The final word went to Stephen Hawking . Obviously delighted   by all the excitement, Hawking had been busily engaged in putting together a message in his computer. Now he played it back:

" Human beings are so desperate for immortality that everyone hopes that, at the very least, his own pet Theory of Everything with survive forever."

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After the dishes were cleared away, Kameshwar C. Wali, followed by Chandrasekar's widow, Lalitha, delivered their reminiscences of the great astrophysicist. As I had learned from several others over the day,

Chandrasekar had been active and alert up to the day of his death. In the summer of the previous year, the two of them had gone to the Shakespeare Festival in Stratford, Ontario. Chandra spent a few weeks studying all of the plays presented at the festival.

Lalitha spoke with real affection about the University of Chicago, their home for half a century. After Chandra's cremation, she and several friends walked about the campus with the urn of his ashes and sprinkled them at his most frequented sites , the classrooms, labs, dining-halls, libraries, bookstores.

Both he and she came from distinguished families of scientists and humanitarians. Her aunt was Sister Subbalakshmi, the most famous figure in the Indian struggle for woman's rights. Chandrasekar's uncle C.V. Raman was himself a Nobel prize-winning physicist, while his father was a noted theorist of Karnatic music.

By all the evidences, Chandra's father, C.S. Ayyar, was a difficult human being. Wali , who does his uttermost in the biography to remain neutral, cannot avoid painting Ayyar as tyrannical and bullying. A simple glance at the photograph that accompanies his treatise on Karnatic music, published in 1951 , confirms as much. It shows a man arrogant, threatened, narrow-minded, yet at the same time very capable, perhaps too much.

The same image of the man came out in the very touching story with which Lalitha brought the evening to an end. She spoke clearly,   in a cracked, quavering voice as befits an octohemigenarian , stopping once in awhile to recover a word, or to ask Kameshwar for a translation. She said that after their marriage in Madras, she and Chandrasekar had gone to Bombay to visit with his father before returning to England. She was so happy at being married at last , she had waited for him for 6 years, that she found herself singing a song , written by a famous composer, which takes as its theme the soul's yearning to be free from the wheel of karma and the torture of endless rebirth.

C.S. Ayyar, overhearing her, railed against her for singing on so gloomy a theme, on a day when she should be looking forward to married life and - most cogently - children. Finally he stormed out of the house and didn't come back again until they'd gone.

Lalitha assumed that Chandra didn't like the song either; but when the incident came up again in conversation he told her that he was very fond of it and encouraged her to sing it as much as she wished. In 1933 when, (under the pressure of the rejection of his work by an astronomical community too craven to stand up against the reputation of Eddington) , Chandrasekar changed his field of research, he asked her to sing it again. Chandra would eventually change his research area within astrophysics 8 times. With each transition came a period of confusion; he never had confidence that the end of

one set of preoccupations would be followed by renewed energy in another direction. In these fallow periods, he would ask Lalitha for the song. It restored him: the doctrine of rebirth has its positive side, because it means that the end of one road must always be followed by the commencement of a new one.

Lalitha finished her presentation by singing it for us . The voice was elderly and infirm, yet confident of itself, the mixture of grief and hope coming through clearly despite differences of language and musical culture. Everyone was deeply moved; one had listened to the lone whimper of humanity in the chilly inflation of astrophysical discourse. It had been made manifestly evident to all of us that for all human beings, the fundamental issues of faith, grief, hope, death, rebirth and love, as exemplified in this touching lyric, were of more universal significance than calculations of information loss in the interiors of black holes.

Not that they aren't fun.

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1 For those who don't know what a spinor is, think of what the square root of a vector might do. Then try to think of 'space' as 'co-time' mediated by the square root of minus one. Twistors are constructed from ordered pairs of spinors in such a way as to incorporate both the 'Hermitian matrices' of Quantum Theory and the structure of the light cone in Special Relativity. Parenthetically, I should add that the problem of how to incorporate spin 1/2 particles, such as neutrinos and electrons, (for which spinors were invented), has been the great half-century-long stumbling block to all efforts at combining General Relativity with Quantum Theory..

For those who don't know what a vector is, you may want to switch allegiances from Ferment to The New Yorker.