Parcellular mechanics and the meaning of length-scale: Radical v.constructive quantisation

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Parcellular mechanics (PM) is a construction of simple connectivity rules for the simplest rational objects. PM space results in a two-valued position basis state for spins (closely related to the Berry-Robbins transported spin basis state) which is considered as reifying the indefinite-dimensional phase space of quantum mechanics in a scale-free limit of the Feynman-Wheeler time-symmetric (or Cramer transactional) representations, whilst producing also the curvature space for gravitation by allowing dual minimal-dimensional (2D) and maximal-dimensional (10^nD) representations of itself.

This is Version 1.0 of a conceptual investigation of the meaning of transition scales and symmetry-breaking in PM, to be completed in later versions.

PM means taking QM seriously

1) A quantum-classical gravity scale . . . ?

Central to all theories, from traditional quantum field theories through string, brane and loop theories to VSL theories and their relatives, is the issue of the transition to a quantum gravity scale. Quantisation of gravity is believed to necessarily imply a threshold of spacetime scale below which spacetime looks quantal, and above which spacetime looks classical. This comes about because combining the fundamental constants *G*, *c* and *h* yields tiny values, the Planck length and the Planck time, which are the smallest space and time units with meaning in the underlying relativistic quantum field theory.

But why in general does quantum gravity (QG) require a scale constant? And more particularly, why one that lives in this very narrow extremal regime?

The straightforward conventional answer is that the standard model of particle physics connects a characteristic *energy regime* - the Planck energy - with a characteristic *interaction scale*.

By saying that long-scale QG effects are not observable physicists mean something different from saying that such effects haven't been identified yet. They mean that QG is an inherently short-scale theory whose effects are hidden away at inaccessibly small scales and large energies because of a *symmetry-breaking* in the early universe at around the Planck time.

The evolution of the universe since this symmetry-breaking is underpinned by expanding FLRW-type solutions of general relativity (GR) with increasing length scale and decreasing mean energy density, so that from one point of view the quantum gravity regime is in effect left behind ("back there") as an echo in the cosmic past, or from another point of view it has become the inaccessible fine-graining ("down there") of an isotropic and homogeneous spacetime described by the GR metric tensor. Today the typical energy density is too low to excite quantum gravitational effects at all.

And this is a crux: The argument proceeds from the premise that no gravitational behaviour detectable *at the present epoch* reveals or implies its quantum nature. This is often construed to be the same, in effect, as saying that GR, which assumes a smooth field of infinitesimally connected spacetime coordinates, is a tried and tested theory valid for all practical purposes. But more pregnantly, and possibly more fundamentally, it is saying that gravitational interactions reveal no evidence of a *common* or *characteristic* interaction scale. In cosmological terms, of course, this is equivalent to saying that they connect *all* epochs.

Now of course, electrostatic potentials also occur on all scales, and the electromagnetic field - like the gravitational - is still said to have infinite range despite the cliche that quantum electrodynamical behaviour dominates in the "realm of the very small". Electromagnetic and gravitational potentials both appear continuous in nature; why should they not similarly converge to their quantum forms in their own short-scale limits? The only difference, surely, is just that we happen to be technically capable of experiencing nature at the characteristic quantum electrodynamical energy-scale; we can't yet experience it at the characteristic gravitational energy-scale.

In this way we are strongly motivated to treat gravity the same by isolating the extremal behaviour of this scale-free system of actions - its theoretical behaviour at small scales and high energies - as the fundamental representation. We do this primarily so that gravity can be incorporated into an extension of the symmetry of the Standard Model of particle physics. The electromagnetic, weak and strong symmetry groups each have their characteristic energy-scales and are separated by them at the "present epoch", but seeking a *unification* at higher energy in the cosmic beginning allows inter-rotation first between weak and electromagnetic symmetry groups, and then hopefully between the electro-weak and colour (strong) gauge fields. GR, by giving the universe a global history of continuously diminishing average energy density which can be projected back to the Big Bang, seems to hold out the promise of bringing gravity into the fold too at a characteristic *grand unification energy* in the Planck era.

This sounds very plausible. But there *is* a fundamental difference: Only gravity couples to *all* other fields through the energy-momentum, not only in this theoretical unification regime but here, now, and in every place and time. Gravitation in GR (and in any underlying theory which is truly dual with GR) is the *generator* of scale and thereby is the glue which couples together these broken force symmetries through cosmic time.

And yet physicists believe GR is sick at heart because, in the very act of approaching this unification, it breaks down. It is temperamentally and "in its bones" not a discretist theory, and to make it so has proved difficult. Perhaps the reason exists outside the horizons of an extended Standard Model? Perhaps GR might turn out to be dual with certain properties of another theory, a theory which provides a similar coupling with all other fields and is also the generator of scale, but which is a non-field, quantum gravity theory of a character as yet unknown?

Could this turn out to be connected with a radical reinterpretation of quantum mechanics itself? Consider that quantum theory still is not "understood", in the sense that although it has achieved huge success as a functional algorithm in electrodynamics and chromodynamics there is still widespread perplexity about its underlying meaning and about how (or if) it transfers from abstracted ensembles of a few prepared particles to the system of nature at large. Evidently this last may bring in the issue of gravity *together with* some resolution of these issues.

Perhaps QM will only find a settled and complete expression when we look at it through the other end of the cosmic telescope and, instead of treating as our baseline tiny intervals at a quantum scale, see instead that these are tiny residual *differences* between actions occurring on intervals of arbitrary cosmic scale. Perhaps, instead of gravitation being the residual ghost of a broken primordial symmetry, the Standard Model of quantum particles is residual, in a novel sense, existing in the constraining embrace of (as it were, in the interstices of) a scale-free and time-free (i.e., non-spacetime) quantum theory underlying both GR *and* QM.

If standard QM arises in the interstices of such a scale-free cosmic principle, how then could we identify a QG energy regime, except as a sum over *all* interaction scales? This would suggest that GR then becomes dual with a path-integral spacetime representation of an underlying nonlocal QG diagram. Interestingly the scalar index of this underlying regime at any GR "epoch" would be, emergently, simply the cosmic gravitational energy, which is a curious quantity.

The cosmic gravitational kinetic energy and the potential energy are both suitably large, but noteably they cancel overall to zero. In Newtonian terms this zero is absolute, and so is in a certain sense not interesting. But a change in the physical meaning of zero occurs connected with a pluralistic relativistic view of nature where the meaning of an absolute zero of momentum becomes impossible to define.

It is quite easy to see that the equivalent of finding an absolute zero of momentum in a relativistic system of momenta is to collapse all position coordinates to a singularity, which corresponds to the effective procedure of generalising special relativity (SR) to GR. But conversely, then, re-expanding the position coordinates produces a plurality of *zero-point* gravitational energy states, and the impossibility of recovering a "Planck era" can be seen to be equivalent to the impossibility of specifying a common *global* zero-point of gravitational energy.

This hints straight away that SR contains a clue, before generalisation, to a radically *discontinuous* function of renormative spacetime connections, a quantised behaviour exposed in a *low energy* (i.e. inertial) relativistic limit. It suggests a zero vector sum of momenta having many changing locally positive and negative values where each connection is one of a scale-free network of distributed *zero-point basis states* for gravitational action, each of which we can describe as containing or representing *virtual* gravitational energy states of the relativistic vacuum. It seems at least possible that from such a construction a *constraint* of the type suggested above, producing particle inertias locally, might emerge. This is our programme.

So is it logically necessary that QG only lives at very small scales and high energies? Or is this just the persuasive conclusion of a theory-dependent argument? To quote Fred Hoyle "We need to be on our guard against becoming prisoners of the time order in which information is stored in our brains".

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2) Back to basics

Planck's treatment of the black body problem was the original and iconic quantum paradigm. I wish to suggest that it is one that has very great generality. The cosmic microwave background (the CMB - which is, along with GR, the iconic cosmological paradigm) shows us the cosmos behaving as a black body cavity (an expectation incidentally pre-dating the expanding big bang cosmology, being calculated at a few Kelvins in the early 20th century for a static universe in thermal equilibrium). The action constant is a scale-free principle, and the Lorenz group of SR is a rotational symmetry group that preserves the action. Could something in SR be pointing towards a structure of spacetime which takes advantage of these facts to reproduce a quantisation condition over *all scales*?

To advertise our program further: PM proposes that this is true, that the universe is a fundamentally plural system of discrete basic structures - intervals on which connections exist - possessing a scale-free self-similarity. These "parcellular" intervals are dual with a limiting nonlocal case of SR intervals mapped by photons at the speed of light, which is a point of view having close connections with spin networks and twistors. But in PM these connections form a *complete graph* network of linear resonant cavities, and the cosmic structure of all such intervals quantises a conserved (emergent) gravitational action. An effect of this discrete structure of intervallic quanta is supposed to produce inertial and gravitational mass at each point of measurement (effectively coming from the radial component of a PM quantum gravity "field") without either a smooth field or its secondary quantisation.

Interestingly this looks back in some ways to a direct action-at-a-distance theory closer in certain respects to that of Newton. But this program reinforces and sharpens the point of the argument that an apparent 'homogeneity scale' cannot emerge from a *fractal* structure. GR, whatever its ontological status, is very accurate on several measures: How can smooth-field GR be dual with a radically fractal theory of cosmic structure? Even if duality could be established for the cosmos we observe, how does a universe which behaves in accordance with GR arise from such a fractal structure in the first place? More specifically, even supposing that the homogeneous spacetime modelled by GR could emerge from fractal beginnings, how can fractal beginnings be consistent with a CMB which is very smooth and very ancient?

The primordial interpretation of the CMB bespeaks some variant of an FLRW-type universe based on GR that evolves continuously in time from a very different early state that was very smooth in space. This very different early state then provides a natural refuge for quantum gravity in a GR universe.

Some quantum gravity theories propose slow secular variations, or rapid primordial changes, in 'fundamental constants', so that (say) c can vary with radiation temperature (frequency) and be different in the very early universe, and the Planck quantities can reduce to equivalence for all possible observers. In such conditions a properly consistent quantum field theory of gravity becomes possible.

But what is actually happening here? A theory developed for understanding photons in Lorenz-invariant quantum electrodynamics is later applied to general relativity, a classical theory of gravitational fields; this procedure predicts quanta of metrical spacetime down at the Planck length; but these metrical quanta are then rendered useless for a theory of quantum gravity because they are not invariant under the metrical transformations of relativity! So in order to turn the Planck length into a quantity which *is* invariant under metrical transformations one effects a theoretical transformation on the entire universe to put it into a state where Lorenz invariance breaks down everywhere so that all observers can find that their calculations give the same value for the Planck length.

Is there not something back-to-front here, suggesting a procedure dictated by the accidental historical order in which ideas have been developed?

In a GR-type expanding universe there is this oddity that the location of a symmetry-breaking, which generates the *meaning* of metrical scale, itself acquires meaning only *in terms of* a metrical scale. The standard cosmological model is inevitably a bootstrap, where a fundamental quantum of scale is both an 'absolute' and, on the other hand, a ratio. The resolution of this antithesis is to separate out the two states to opposite ends of cosmic time within an evolving grand symmetry where a universal 'absolute' scale of quantum spacetime freezes out, as it were, crystallising at the extreme lower bound of relativistic metrical scale. But why should this single-valued 'Planck length' be so significant in a pluralistic universe? Why should one 'end' of cosmic time be special (which is of course just the space scale paradox shifted onto a dimension of time)? This subordination of ratios to absolutes fights against the principle of relativity. Why should time have a 'beginning'?

The internal answer is that the general-relativistic gravitational curvature demands (paradoxically) the existence of a priveleged cosmic location, an inevitable singularity at the origin of spacetime, and the scalar and temporal asymmetries of physics at our epoch result from the breaking of an original symmetry. But what if there were a different way to resolve the antithesis of absolute and rational scale? What if this could be done inside a theory that was radically quantised without going through the intermediate stage of having to deconstruct a geometrical description based on classical theories of continuous media? What if this theory involved a type of symmetry-breaking that implied no priveleged cosmic spacetime location? Such a theory could be radically quantised *and* radically relativistic.

With no real global time origin and no real 'big bang' there could be no hot phase of thermal equilibrium to explain the CMB, nor any global continuous secular variation in c, so VSL could not work within it in the same form. But what if radical quantisation *itself* implied a discontinuous renormalisation of *c*?

Imagine (as a pedagogical cartoon for the moment) a fractal structure, a network composed of 1-D units of action quantised at each vertex by such renorming, where there need be no *actual* cosmic past and no actual expansion. Instead of gravity quanta precipitating like scalar dregs to the bottom of the spacetime medium they would be distributed as short- and long-distance correlations occurring like a crystallisation phase over *all* scales, and because this complex fractal 'medium' emerges (in imaginary time) coupled directly with - because isomorphic to - the 'particle' distribution, then the cosmic structure is automatically the state of maximum gravitational entropy without being metrically smooth, and the resulting effective 'stationary cavity' leads naturally to the possibility of a radiation equilibrium without an initial hot phase of thermalisation.

But the 'problem' is that GR is the only worthwhile theory of gravity that theorists have available, and in GR gravitation is identified with the metric. Quantising gravity is thus taken to mean quantising the metric, hence the 'smallest length', 'smallest time' etc. This is a type of programme that we might call constructive quantisation, to distinguish it from a *radical* quantisation of the sort just speculated about.

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3) . . . or a scale-free invariance?

The conclusion drawn from GR that the gravitational symmetry-breaking picks out a unique energy or scale regime is a bootstrap. It is not necessarily invalid because of that, but it causes us to wonder if the spacetime modelled by the metric tensor might be a secondary *representation* of quantum gravity. If so, then it may be that an underlying symmetry-breaking picks out a characteristic quantity on some other dimension of GR which is invariant at *all* scales and thus at *any* epoch.

The global causal dipole (original high energy density, future dissipative expansion) might prove to be an inappropriate projection for the purposes of understanding what gravity truly is. It is after all only a mapping of a spacelike-connected structure in imaginary time. Perhaps there is a better mapping, perhaps with a more intelligible thermodynamic structure?

Consider an analogy. A computer simulation of a highly diverse system can be analysed on-screen into a uniform lattice of pixels of a very small size, but the software code which generates this 2D space lives elsewhere and is completely scale-free. The simulation "breaks down" in the sense that nowhere on the screen can we find the algorithm that generates it. But this is not because there is a limit of resolution in the display. The underlying order does not exist inside those pixels and no amount of reductive analysis of pixels will reveal it.

When the characteristic energy of interactions in a system is the Planck energy then it is expected that quanta of metrical curvature of the order of the Planck length will act like well-behaved gravitons in some quantum field theory of spacetime defined at this characteristic scale, a "quantum foam" or perhaps a knotty structure of miniscule string loops. But the rational units by which we define the Planck era, expressed as c.g.s. values, are *improper* quantities, i.e. they are units that borrow rational meaning from their projection on the screen of future spacetime, which is our relativistic field of observation. The *proper* characteristics of this regime, which is supposed to occur at the Planck time 10^{-43} seconds 'after' the big bang, are not rational.

The Planck era itself is characterised by the fact that the uncertainty in the measurement of length or time becomes equal in some sense to the absolute scale of the universe, so it becomes impossible to define the meaning of a rational interval or a rational energy. All rational interior relations have broken down and physicists represent this by setting *G*, *c* and *h* all equal to unity.

Between our world and this *arelational* regime GR cosmology places an uncrossable gulf. Or more correctly, such a gulf is revealed by a shortcoming of GR which occurs in a scale regime very far indeed from the troublesome minutiae of quantum fine-graining: scales beyond the light horizon.

This gulf is dramatised by the parable of *cosmic inflation*, which supposedly stretches space to a vast scale faster than light can follow and so destroys any metrical link between the essentially relational relativistic universe we know and the *a*relational Planck era. In that era, 'initial conditions' can be just about anything at all (which obviously is one of the benefits of the inflation scenario) and not only does it make no difference what temperature or size the universe then is, there is no way to give meaning to these concepts.

This allows us (I suggest) to infer the proper natural meaning of "the Planck scale". In these conditions the proper characteristic of spacetime quanta reduces to the exhaustive *equivalence* which they all recover in this limit. That is, all spacetime quanta have the Leibnizian identity of indiscernability in principle, and in the absence of rational units of measure we have to assign them an interchangeable *imaginary unit scale*, where unit energy expended in unit time is everywhere equivalent to *unit action*. So, what if we take the quantum *equivalence* to be the essential characteristic of the quantum gravity regime (where scale and energy are singular and undefined), rather than a particular characteristic scale or a characteristic energy (real values of which are evidently associated only to relativistic vector quantities)?

Trying so hard to recover a discrete scalar uniformity in the general limit of a theory whose essence is continuous tensorial diversity does seem perverse. Also, the anomalously inverted entropy of classically gravitating systems, where the structure-forming negentropy is counterintuitive, is imported into QG along with the idea that the equivalence is hidden at an extremal metrical scale. This problem - gravitational negentropy - is connected with the negative gravitational potential, and thus, at root, with the oddity that there is any diversity of scales at all in a spacetime that supposedly starts out extremely uniform. Thermodynamically this is all difficult to understand, but the problem might be avoided in a scheme where the quantum structure of spacetime is associated to its general vectorial *diversity* instead of its extremal smoothness. The preservation of an underlying QG uniformity, in the form of a dimensionless "Planck scale", far from the extremal condition (i.e. its distribution over all scales and energies, contrary to GR) would chime with the theoretically desirable preservation of maximum gravitational entropy at any epoch (or scale).

Such a scale-free democracy would be more rational (in both meanings of the word) than a fascistic gobal theory, and such democracy is actually an "obvious" feature of quantisation of *action*, which is the fundamental invariant in QM. We notice that SR (special relativity) already conserves action for all observers in tandem with a pivotal scale-invariant equivalence, inside a vectorial transformation which has no preferred scale, no boundary and no singularity in time.

Are we looking in the right limit of the right relativity theory?

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4) Null gravitational action in SR as a quantum basis state

It is very noticeable of course that spacetime, as it is measured out by the relations between the 'particles in it', is far from having a single well-defined scale. We have pointed out that this rational spacetime is *by definition* constructed from a scatter of all possible length scales. It is also noticeable that SR localises the specifications of physical quantities, making the ether redundant, and Lorenz invariance is especially adapted to a universe of linear null-signal connections on arbitrary scales. In its conception (though not in its later development) SR in certain ways fights against the ancient notion of space and time as monistic media. Is it coincidence that SR appeared just about the time that the traditional model of continuous fields in electromagnetic theory was breaking down into photon exchanges? Perhaps there is a still-hidden significance in the fact that both of these conceptions matured in the mind of the same person in the same year.

One might well ask why continuity has continued to hold sway. The fact is that the implications of quantum theory took a long time to be worked through, and because of this the concurrent emergence of relativity (an action invariance) and the quantum postulate (an action invariance) actually worked against the chance of a natural discretist *rapprochement* being discovered. QT took a couple of decades after Einstein to achieve a really manageable form; but scarcely had SR settled in when in 1908 an imaginary medium was invented by Herman Minkowski to simplify it.

His very elegant treatment of Lorenz transformations as rotations in a four-dimensional manifold with negative time has the effect of seeming to set SR back in the context of a classical theory of continuous media. General relativity then works by applying a continuous transformation to this metrical medium. Yet it is precisely in respect of continuity that GR is known to be wrong, and in recent years it has come to be quite well-understood that inside a monistic GR cosmology there is a *pluralistic* theory trying to get out.

What is all this trying to tell us about the relationship between SR and a quantised theory of gravitation?

Let us think about what classical gravitation is, considering first just a pair of mass points in free space: The total gravitational mass energy of any freely gravitating system mc^2 cancels against a negative gravitational potential energy, $-mc^2$, so the total gravitational energy at any time is classically zero. This is the same as saying that "rest" mass = "gravitational" mass and that this quantity is independent of any other mechanical forces (i.e., is a given constant).

When we bring in other forces, then the gravitational mass-energy sums over all energies possessed by each particle as a result, and the acceleration due to gravity increases. But still the total gravitational energy of the system, instantaneously, is zero because the interaction with other forces donates both mass energy and an equal and opposite negative potential energy. From this point of view since t x 0 = 0 for all values of t the classical gravitational action remains conserved at zero however the system evolves in time.

Action is a conserved quantity in relativity, but of course it is not appropriate, from the point of view of local-real physics, to speak of the state of the system at "an instant", since only two mass points co-located in one infinitesimal domain can share the same value of t in the frame of any possible observer. Locally, the measurable (i.e. *improper*) action on one definite particle is its non-zero gravitational kinetic energy taken over some non-zero interval of observer time, and the null cancellation is only ever actually recoverable at a future singularity. So this instantaneous cancellation represents in SR terms only an inaccessible *proper* state of the whole system. Relativistically this is the same as saying that the instantaneous cancellation is a *nonlocal* property, which is nevertheless quite compatible with local-reality because the no-signalling condition is obeyed on this phase of the individual action.

Another way of approaching the same position is to notice that instead of reducing the energy to zero we can reduce the proper time to zero with the same effect, and in SR conserved action has the special value of zero for the pivotal case of null signal lines (photon trajectories) where the interval is always properly (radially) zero. In fact from one point of view the Lorentz transformations are none other than a way of ensuring that this zero of proper (radial) action is conserved universally for all differently moving improper observers.

Now, as well as conserving proper action at zero on null signal lines, SR also happens to be a symmetry for conserving gravitational *force* at zero between all particle pairs to which its transformations apply - which are thus "inertial" particles. Conventionally we go on to say, in the language of GR, that the same inertial particles can at the same time be described as accelerated, by reference to the deformed spacetime metric that we call the gravitational field. SR is therefore often described as a theory whose flat spacetime "does not include gravity". But it is more pregant to describe it as a theory of *null proper gravity.*

The question is, how do we then get from this pivotal condition of zero *proper* gravitational force between pairs of inertial points in SR to a non-zero *improper* gravitational force among larger ensembles of such pairs?

The procedure of GR is one way of doing this, equivalent to mapping local Lorentzian SR (which is a linear model in both senses) *down* onto a local continuous Riemannian metric, where it survives as a pseudo-scalar limit case, representing states of infinitesimal domains in a curved spacetime. The deformed geodesic structure of 4-space then represents the gravitational tensor potentials between scalar mass points with *single-valued* position states (i.e., a particle occupies a point and a point is defined by one set of 4-space coordinates).

But, contrarily, we can see that there is (in principle) an equivalent inversion of this mapping, which would be to map the infinitesimal domains of the GR metric tensor - or *functional representations* thereof - *up* onto local SR intervals, effectively projecting points (formerly occupiable by scalar masses) as unit vectors, where they would survive as a pseudo-scalar limit case. This process, which we can think of as redefining the "point" in a new state space, produces *two-valued position states* (not as odd, from the point of view of quantum theory, as it may at first sound) from singular ones, stretched null domains upon which, in the emergent pluralistic improper metric of flat Lorentzian spacetime, light signals live.

If we then notionally reduce away all "other forces" (for a usual first approximation "other forces" means charge, or light in QED) what's left is a force proportional to something called mass, which is just another name for the local inertia. PM says that this is an essentially pluralistic and emergent constraint, which *does not exist primitively* (properly, non-locally) between pairs of position states. It emerges only locally (i.e., only *im*properly) among ensembles of nonlocal position pairs or *dipoles* each of non-relativistic *unit length* imported into the non-rigid SR metric as an embedded *rigidity* . This radial (proper) component of the forceless inertial transformation acts as an *effective repulsion* (the proper rigidity of the underlying nonlocal object)which then introduces a transverse (improper) force between local position *monopoles* proportional to emergent Lorentzian angle. The resultant *constraint* is what we call gravitation, which can be seen from this point of view as a "hidden" property of the electromagnetic gauge.

From a particle physics point of view, we will see that this appears to be equivalent to finding the *nonlocal* spin-zero phase of the action and taking it to represent an inflated "point" in the phase space for the gravitational action on an interval between our pair of particles.

From a geometrical point of view, this flips the conventional view inside out. Our scale-free two-valued "point" could be thought of as importing a *hyperbolic geometry* into signal lines in flat semi-Euclidean spacetime. It appears possible that this procedure is analogous to generating the light-like null geodesic structure of the Einstein metric inside SR as the lower bound of an *inflationary potential* in the spacetime structure, at the level of what we can think of as the *inertial basis state* for a gravitational dynamics.

Quantum theory obviously requires populating all zero basis states with a tiny but *non*-zero minimum action. If the null-basis-state case corresponds to the inertial (flat metric) field then we can understand, in a very general way, that somehow the populated-basis-state case ought to correspond to the accelerated (curvature tensor) field.

And note also that making this the basis state for a gravitational quantum condition would be equivalent to defining a quantum theory of gravity in the *low*-energy limit of the classical theory, not the high-energy limit. As already intimated this could have certain thermodynamical advantages in terms of the inverse entropic behaviour of gravitating systems.

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5) Producing non-zero action from the inertial basis state

Of course a low-energy limit is one thing; what we have so far described is the *zero*-energy limit of the classical theory, and that's quite another. Unless a gravitational force can be produced from such an empty basis state then it remains a literally empty metaphor.

The inertial basis state does not give us a useful quantum theory: An action of zero is not a rational quantum and does not transform with the tiny but non-zero Planck constant in QED, $h = 6.626176 \times 10^{-34}$J/sec. Equally obviously, conserving gravitational action at zero in SR is just a concise statement of why SR is *not* a useful theory of classical gravity. So how can we have a non-zero inertial basis state of gravitational action - call it h_g? Isn't this just a contradiction?

Not necessarily. Consider that we can have a null basis state for time in the form of the proper $s^2 = 0$ interval of a photon track, yet this basis state is populated by all manner of positive real times in the expansion to the *pluralistic* case of many relativistic frames. The essence of the SR transformation is the singular absoluteness of *c* borne along like a surfer on a standing wave through a rich landscape of plural relativism, a fascinating Escher-like impossibility achieved by trick of mathematical perspective.

If it seems strange to think of *c* as a "constant of floating norm", a zero-point associated with a renormalisation or regauging occuring anew at each scattering vertex, then consider that in the Minkowski representation of SR all particles are considered to move at the speed of light through 4-space, their real momentum vectors emerging from four-rotations in this manifold. From this point of view *t* becomes improperly non-zero in the breaking of a supersymmetric light-like symmetry to the boson+fermion representation.

In a continuum theory this renorming would be like a breaking of the direction of a singular light-like null line at an infinite number of infinitesimally separated points, a smooth refractive curvature of zero real radius. But in a renormative discrete theory we can think of this as like a dispersion due to a *quantised* change in refractive index. The line breaks through Lorentzian scattering angles into a multiplicity of improperly-specified metrical intervals with the elicitation of fermionic mass, which incurs a "slowing from *c*". But in this emergent new symmetry group, contractions and dilations of time and length are so arranged that all differently-moving observers still always measure its gauge boson (photon) to be travelling at *c*.

This quantity *c* is improper *unit speed* for the gauge, underpinning the ratios of definite spacetime intervals. Alternatively, from the point of view of this gauge, there are no definite spacetime intervals and a photon "travels" at all possible speeds at once, or at none at all. Only the breaking of *direction* remains significant, resetting the effective (improper, transverse) zero-point of the gauge.

PM proposes that we can get h_g into SR - as a purely phenomenological or topological factor initially - in the form of a *non-zero basis state* if we say that the zero of action, like the zero of time found by a photon track for a *unit scale* position dipole, is a *false vacuum* zero-point in the distributive plural relativistic vector field of emergent position monopoles.

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6) . . . under construction . . .