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科学技術庁傘下の特殊法人理化学研究所は、我が国の基礎研究を強力に推進するため、平成10年度の基礎科学特別研究員を募集します。 斬新な研究課題を自主的に遂行できる若い研究者の応募を期待します。

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理化学研究所

SCIENTIFIC MEMBER AND DIRECTOR
Max-Planck-Institut für Metallforschung
Stuttgart, Germany

Applications are invited for the position of a scientific member and director at the Max-Planck-Institut für Metallforschung. We seek applicants with expertise in the field of theory of mesoscopic phenomena in materials.

The candidate must have a distinguished academic record and an active interest in interdisciplinary research. He/she will head a research division which should focus on the theoretical aspects of macroscopic properties of complex materials systems in relation to their microstructure. Depending on the background of the candidate, structural (mechanical) properties and/or functional (electric, ferroelectric, magnetic) properties should be emphasized.

Interested applicants should submit a resume complete with CV, research areas, list of publications, and reprints of their five major publications to the Executive Director of the Institute, Prof. Dr. Manfred Rühle, Max-Planck-Institut für Metallforschung, Seestrasse 92, D-70174 Stuttgart, at their earliest convenience but no later than **March 31, 1997**.

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POSTERMINARIES

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Theorem: Applying the rational, logical thought processes of science to society, indeed to civilization itself, inevitably, leads to useless, superficial results. *Axiom 1:* Recasting trivially obvious observations ultimately leads only to pronouncements of trivia. *Axiom 2:* Gross generalization inevitably leads to zero utility. *Corollary:* In order for science to explain phenomena, and test its own hypotheses, it makes many simplifying, idealizing assumptions about the system under study. *QED.* Let's try anyway! How would we go about constructing an equation of state (EOS) for the whole shebang?

Start with time t (plenty of it) and spherical spatial coordinates $\mathbf{r} = r, \theta, \phi$ on which to frame the problem.[1] A basic function that will enter all interesting evaluations is the instantaneous time- and position-dependent population density on the planet, $\mathcal{N}(t,\mathbf{r})$, in number of people per square meter.[2] We know $\mathcal{N}$ is actually the culmination of millennia of evolution and should properly be written as $\mathcal{N}(t, \mathbf{r}) = \int_{t_0}^{t} \mathcal{E}(t, t', \mathbf{r}, \mathbf{r}')\mathcal{N}(t', \mathbf{r}')dt'd\mathbf{r}'$, taken over all space, where $\mathcal{E}$ is the evolution operator[3] and $t = t_0$ is an adjustable cutoff parameter lying in the range -5000 BC $\geq t_0 \geq$ -50,000 BC.[4] Naturally, $\mathcal{N} = \Sigma_i \mathcal{N}_i$ and $\mathcal{E} = \Sigma_{ij} \mathcal{E}_{ij}$, where i,j run through every national, religious, racial, and gender grouping one can think of. Clearly the $i \neq j$ cross terms in $\mathcal{E}$ are crucial to getting the problem right and are not to be found in even the best almanacs.

A second basic set of functions, $\mathcal{R}(t,\mathbf{r}) = \Sigma_i \mathcal{R}_i(t,\mathbf{r})$, describes the disposition of the rest of the global environmental resources (i.e., anything but people) where i runs through such things as animal life, biota, climate, desert, fossil fuels, arable land, minerals, pollutants, bodies of water, etc. Each $\mathcal{R}_i$ naturally has many of its own subcategories. The evolution of any of these environmental factors is the sum of a self-evolution term and a human-interaction term. The eruption of Mount St. Helens is an example of the former and the near extinction of the American buffalo, the latter.

Lastly, we must define the output functions that we want to compute with some predictive ($t >$ now) power. Every conceivable phenomenon of interest can be defined in the same frame. E.g., concentration of wealth $\mathcal{W}(t,\mathbf{r})$ in ecu/m^{2}s, illness rates $\mathcal{I}(t,\mathbf{r})$ in (morbidity + mortality)/m^{2}s, conflict intensity $\mathcal{C}(t,\mathbf{r})$ in combatants/m^{2}s, and so forth. These will all be encompassed by the ultimate EOS.[5] How do we proceed? So far, all we have done is define stuff. The two substantive challenges are (1) finding methods for construction of evolution operators from a knowledge of the forces that drive evolution and (2) identifying those forces.

Challenge (1) is a mathematician's dream and is beyond the scope of POSTERMINARIES. Suffice it to say that the

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nature of evolution is multiplicative in time, as opposed to additive. Thus we would expect the operator to appear schematically as

$$\mathcal{E}ij(t,t',\mathbf{r},\mathbf{r}') = exp\{\int_t^{t'} ln\, \mathcal{S}_{ij}(t'',\mathbf{r},\mathbf{r}')dt''\}$$

where the $\mathcal{S}$s are the force terms that we need for challenge (2).

How do we get the $\mathcal{S}$s? Well, first we describe the manifold behaviors in all human pursuits from the level of the individual to the nation state. Then we apply a taxonomy that categorizes the classes of behaviors and identifies the interfaces between them. Finally, we posit cause-and-effect relationships operating across each interface that reflect the stimuli and responses characteristic of the species, us. Examples of fundamental and derivative sociological behavior factors would be self-preservation, procreation, avarice, love, territorialism, language and literacy, hunter/gatherer instincts, ingenuity, belief systems, etc. Every behavior would include a subset of causal factors that are interactions with all relevant environmental resources $\mathcal{R}_i$.[6] Every $\mathcal{S}$ would have an instability measure built into its dependence on t and on $|\mathbf{r}' - \mathbf{r}|$.[7,8]

We have formulated a large multivariate problem with up to $\{\Sigma_i \int^t dt[\mathcal{R}_i(t,\mathbf{r}) + \mathcal{N}_i^{\cdot}(t, \mathbf{r})\, d\mathbf{r}\} - 1$ degrees of freedom. Taking the scientist solving the problem out of the equation (thus {} - 1), is a key to convergence and, dare we say, objectivity. Another key to convergence relies on seeking probabilistic rather than deterministic solutions. The overall constraint (essentially that all probabilities sum to unity) keeps the otherwise infinity of outcomes in check. Determinism is anathema to advocates of free will anyway. We thus allow freedom at the level of the individual and predict outcomes in the aggregate.[9] The last key to convergence is a renormalization which is the mathematical analog to humans coping with the psychology of time. Just as the bare elementary particle dresses itself by polarizing the vacuum into virtual particles moving forward and backward in time, we dress our actions with a sense of history and anticipation that continually adjusts to events and avoids singularities.[10] The way the current price of a stock issue *equals* the expected future price based on prior information (even though we know the actual future price will be different) epitomizes this process. "Mortgaging our future" and "eating our seed corn" will be more than clichés once we've demonstrably cracked this problem.

If you think this whole problem is intractable, think again. Most fields that study human and environmental phenomena have cast their problems in numerical (if not analytical) form and computer algorithms explain observations and predict outcomes. Models for macro-economics and global climate change are quite familiar. But many other fields, such as sociology (demographics), management and logistics, ecology, battlefield strategy, and linguistics, are modeling too. Only perhaps theology lags behind. With today's immense computing power extrapolated into the near future (renormalized, of course), is it that unlikely that all these models could be synthesized into one? Of course not!

Finally, we owe one small practical hint to the analytical heavies who will undoubtedly weigh in now that we have laid out the problem. The multitude of couplings between every variable and function in the problem is clearly the biggest obstacle to solution. It is well-known, however, from analogous physical systems that we can treat this problem as one of coupled oscillators with all the field theoretic implications. We will thus find normal modes, creation and destruction operators, and a plethora of interacting quasiparticles with, thankfully, integrable form factors after renormalization. We can then easily describe collective phenomena such as WWI, WWII, the baby boom, and the Beatles. Scattering between quasiparticles and associated cross sections will easily explain other observations. This approach requires transformation of the whole problem into reciprocal (societal) space where all the operations reduce to simple arithmetic and the transformed population state vector $\mathcal{N}_k^{\cdot}(\boldsymbol{\omega},\mathbf{k})$ is directly related to people power ($\boldsymbol{\omega}$) and position in society ($\mathbf{k}$). Everybody's favorite discipline projects onto just one more neighborhood in k-space.[11]

There are many advantages to the reciprocal point of view. It could even be adopted well before we ever actually do any math, purely as a Gedanken experiment. The reciprocal landscape puts all developing nations at one big near-delta function in the economists' region of k-space. The land masses and the oceans reduce to two great peaks in the ecologists' region. Uniform worldwide atmospheric pollution is an unmistakable spike at that region's origin. The vast communications network among globally distant nodes becomes a new net where the reciprocal node density is highest, you guessed it, right there by the delta of the developing nations. No longer can one hide behind the implausibility of the "action-at-a-distance" hypothesis to deny, for example, the effect of a trade deal here, on hunger there. Creation at the apex of affluence must be accompanied by destruction on the pile of poverty with all the reciprocal space polarization that implies. It's simply a matter of fields and physics, with a smidgen of retarded philosophy. If you've now become enthused about capturing all global intercourse under a single algorithm, you are strongly advised to review our initial theorem.

E.N. KAUFMANN

1. The magnitude r of the position vector $\mathbf{r}$ is assumed constrained between the deepest mine shaft and orbiting space stations, if any, and we neglect the oblateness of the planet. The $\theta = 0$ axis is taken along the Earth's geographic north pole. The $\phi = 0$ plane may pass through any town of choice, but Greenwich, UK seems a timely starting point.
2. A rising $\mathcal{N}(t) = \int\mathcal{N}(t, \mathbf{r})\, d\mathbf{r}$ is, of course, the basis of the Malthusian catastrophe.
3. Also often referred to as the "propagator" or, in this application, the net result of "procreator" and "grim reaper" operators.
4. The upper limit of evolution integrals is taken to be t, the instant of interest, even though we know that current events are influenced by future expectations. The evolution operator is renormalized appropriately (as discussed later) to account for this apparent paradox.
5. Naturally, every effort should be made to adopt existing symbols and terminology already used in the life, social, and political sciences. Note that each of these components enter the EOS in combination with $\mathcal{N}(t,r)$ because it is always the influence on or by significant numbers of people that we care about.
6. These would directly insert such influences as plague, draught, pestilence, energy supply, and available parking at urban malls. At the same time they would contribute to the human-factor term in the resource evolution operator.
7. These would facilitate the evolution operator's obligation to predict the triggering of cataclysms buy such as the assassination of the Archduke Francis Ferdinand, the sinking of the S.S. Lusitania, or the crash of '29.
8. You'll notice that we have couched the discussion in the psychologically palpable idea of forces. In fact, it is interaction energetics that will actually be employed. It will define the topology of a global multidimensional potential energy surface whose cusps are our paradigm shifts and sea changes and whose minima are life's ruts and paths of least resistance.
9. Imagine if each molecule in a gas could decide for itself whether or not to collide with the wall of its container and, if so, decide how much momentum to impart. P would still equal nRT/V even though the T is now psychologically distributed over the n.
10. Perhaps this was best expressed by Richard Avedon (*An Autobiography*, Random House, New York, 1993) where he notes in the introduction, "I haven't lived chronologically. No one does. Each moment reaches backward and forward to all other moments. The interweaving of elements from my life's work—out of chronology, as echoes and foreshadows—is true, I think, to the inner shape of any life."
11. Of course, basic science occupies a k-space neighborhood that forms an impenetrable shell at very large $|\mathbf{k}|$, just beyond the reach of all but the most educated and energetic quasiparticles.