determines whether and which representations $D^{(j_1, j)}$ of G can be realised on TQ.

Various models studied by others can be recognised in our general formalism. The original Hanson-Regge model has $H = e, Q = G$, and the Lagrangian is defined on $TM \times T\,SO(3, 1)$ and has an internal SO (3, 1) symmetry. It is a second order theory in our nomenclature. The choice $H = N$ leads to a first-order internal space which is the spinor model of reference (3): the latter is a "two-fold covering" of the exceptional orbit $\theta_{0,0}$. The case $H = SU(1, 1)$ gives a second order theory identical to the vector model of reference (3). The model of Barducci and Lusanna[10] uses an internal space $SO(3, 1) \times R^3$ which is not transitively acted upon by G: in our terminology this is therefore not indecomposable or minimal. The particle with a dipole moment studied by Cognola *et al*[11] uses a Lagrangian which is of first order in the internal variables, but the corresponding internal space is again non-minimal. With additional kinematical restrictions, their Lagrangian can be rewritten in a second order form on an indecomposible internal space. This again corresponds to $H = SU(1, 1)$. Further connections to available models in the literature are given in reference (5).

19 March 1985

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NEWS

PLANTS GET A CHARGE OUT OF SUNLIGHT

. . . Roger Leblanc (U. Québec, Trois-Rivières) and James Bolton (U. Western Ontario) are investigating the role of solar photons in photosynthesis. "The best way to appreciate what goes on in photosynthesis is to follow an incoming solar photon as it impinges on one of [a plant's] photosystems. 'The first structure that such a photon encounters at the membrane surface is an "antenna chlorophyll," ' explained Leblanc. 'This chlorophyll molecule absorbs it, thereby raising the molecule's energy level to what chemists call an "excited state." There are clusters of up to 400 of these antenna molecules bonded to proteins in each photosystem and they act as a sort of photon concentrator. Once the photon energy is converted to an excited state of the chlorophyll molecule, it is passed down below the surface via other chlorophyll molecules through a kind of stepwise induction process. By induction I mean that no electron transfer takes place. Rather, the excited state is passed along from one chlorophyll neighbor to the next until it reaches a site within the complex called the "reaction centre" ' . . . According to Bolton, the reaction centre chlorophyll-protein behaves much like a man-made photovoltaic cell in this process; these silicon-based structures work by setting up regions of positive and negative charge (like the leads on a dry-cell battery), using sunlight to drive the separation. 'If it were possible to place electrodes on either side of the reaction centre protein,' explained Bolton, 'you could draw off an electric current.' "

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