on the physical space, and then translating it, (via our boosted identification), over the corresponding Cauchy surface in the covering space. We can then see what function space the physical data must lie in for the corresponding non-physical data to be in the Sobolev spaces required for the Cauchy problem to be well posed.

With an appropriate choice of Sobolev space for data on the physical Cauchy surface, it appears that our test scaler field remains finite as we approach the chronology horizon. For these cases it will be interesting to see if there is some way to extend the data through the chronology horizon so that one can examine the behaviour of the test fields introduced in the CTC region as they approach the chronology horizon.

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Moór's Integral and General Relativity

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Einstein stated in 1916 that physical laws must be expressed in an invariant form relative to general coordinates transformations. Therefore the covariant derivative plays in General Relativity (GR) an important role. In order to ensure the invariance of an integral the tensorial density is introduced, but before the integration this has not an invariant character.

In 1951 A. Moór (*Acta Math.***86**, *71-83*) defined the invariant integral as the inverse operation of the absolute differential. We tried to adjust Moor's integral for the necessities of GR, results we sinthetized in 1977 (*Periodica Math. Hungarica* **8**, *57-64*).

If V_n is a n-dimensional differential manifold, $T_x, T_{x'}, T^*_x, T^*_x$, the tangent and cotangent spaces in $x \in V_n$ and $x' \in V_{n'}$ then

$$\omega\varepsilon(\otimes_\alpha T_x) \otimes (\otimes_\beta T^*_x) \otimes (\otimes_\gamma T_{x'}) \otimes (\otimes_\delta T^*_{x'})$$

is called a double tensorial form. The exterior derivative d_x (or $d_{x'}$) defined in terms of connection, torsion and contorsion satisfy the well-known axioms and the Stokes-type formulae

$$I_{(S_p)}\omega = I_{(S_{p+1})}d\omega \ ,$$

I being Moór's integral. $I\omega$ gives the physical quantity observed in x'. The invariant character of conservation laws is now guaranteed.

In last few years S. Vacaru (PhD Thesis, 1993) applied the nearly autoparallel (geodesic) maps (nam), respectively (ngm) introduced by N.S. Singukov (Dokl. Akad. Nauk SSSR **151** (1963), 781-782, in Russian), to a seria of problems of GR, Moór's integral and conservation laws. These results can also be generalized to Lagrange spaces.

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Time Machine as 4-Wormhole in the Spring Space-Time

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Let $< V^4, g_{\alpha\beta} >$ be a leave of a foliation $\mathcal{F}$ of codimension 1 in the 5-dimensional Lorentz manifold $< W^5, G_{AB} >$. If the Godbillon-Vey class $GV(\mathcal{F}) \neq 0$ then the foliation $\mathcal{F}$ has a spring leaves. Hence there exists an arbitrarily small neighborhood $U_a \subset W^5$ of the event $a \in V^4$ such that $U_a \cap V^4$ consists of at least two connected components U_a^1 and U_a^2.

Remove the 4-dimensional balls $B_a \subset U_a^1, B_b \subset U_a^2$, where an event $b \in U_a^2$, and join the boundaries of formed two holes by means of 4-dimensional cylinder. As result we have a 4- wormhole C, which is a Time machine if b belongs to the past of event a. The past of a is lying arbitrarily nearly. The distant Past is more accessible than the near Past.

Evidently real global space-time V^4 is a spring one, i.e. is a spring leave of some foliation $\mathcal{F}$. It follows from the conformal Kaluza-Klein theory that the movement to the Past through 4-wormhole C along geodesic with respect to metric G_{AB} requires for time machine of large energy and electric charge [1,2].

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Holonomy in General Relativity

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In general relativity theory advantage has often been gained by having access to one or other of the various mathematical classification schemes (e.g. the Petrov classification and a similar one for energy-momentum tensors) that have been developed for space-times. Another classification scheme for space-times, using the *holonomy group* of the Levi-Civita connection associated with the space-time metric, can be constructed. It has the feature that, whereas the Petrov type of the Weyl tensor or the Segre type of the energy-momentum tensor will, in general, vary from point to point in space-time, the holonomy type is a single statement about the global space-time.

To avoid complications, suppose that the space-time M is simply connected (or, alternatively, that one restricts to a simply connected region of (M). Then the holonomy group associated with M is a *connected* Lie subgroup of the identity component $\mathcal{L}^0$ of the Lorentz group and hence is determined by the choice of a subalgebra of the Lie algebra A of $\mathcal{L}^0$. Since the subalgebra structure of A is well known all potential holonomy groups for such space-times can be found and, it turns out, all except one particular type can be realised by some space-time [1].

The main mathematical techniques required in dealing with this holonomy approach are based on the theorem of Wu [2] which is a generalisation to Lorentz metrics of de Rham's decomposition theorem for positive definite metrics. Full details of holonomy theory can be found in [3]. Since the specialised holonomy types require a certain type of "good behaviour" under parallel transport, one is led to the study of *recurrent and covariantly constant* tensor fields on M.

The situation for vacuum space-times is known and the holonomy classification there is complete [4]. Work will soon be completed on the holonomy types of many non-vacuum space-times (with D.P. Lonie). The holonomy classification can be linked in a precise way with the other algebraic classifications mentioned above and has proved extremely useful in dealing with certain symmetries of space-time, especially affine and projective collineations.

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Gravitation with Torsion and Stringy Matter

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A theory of gravitation with torsion, and the resulting field equations, are discussed. The theory is based upon a torsion that is derived as the exterior derivative of a potential two form.[1] The geometrical part of the Lagrangian is simply the curvature scalar of U_4 spacetime. The conservation laws follow from the Noether identities and are identical to those obtained from the Bianchi identities. From these the propagation equations are derived, and the correct conservation law for angular momentum is obtained provided that the source of torsion is interpreted as the intrinsic spin of a particle. The material source may also be formulated in terms of the Dirac Lagrangian, for which case the theory is recast in tetrads.[2] The Dirac equation ...