ISOCH – Lagrangian Structure (Part 1 of 5)

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Formulation and Energy Balance of the Matter-Dynamics Rate χ_{MDR}

The Lagrangian formulation constitutes the theoretical foundation of ISOCH dynamics. It describes the matter-dynamics rate χ_{MDR} as a process-normalized rate quantity whose temporal evolution follows directly from a variational principle. In this way, the empirically determined epoch-dependent drift of matter dynamics is not treated merely as an observed correlation but as a necessary consequence of a fundamental variational equation.

Within the ISOCH framework, the Lagrange structure extends the geometric description of spacetime by a process-normalized matter-dynamics rate χ_{MDR}, whose equation of state emerges from the action principle; the geometry remains explicitly preserved as the metric framework. The matter-dynamics rate χ_{MDR} acts as a universal parameter of the material process velocity and—through its potential $V\big(\chi_{\mathrm{MDR}}; \alpha(\varepsilon)\big)$—determines the interaction between local dynamics and cosmic expansion.

This derivation ensures that the ISOCH equations are not phenomenological but derived from a consistent variational principle, and that the observed trends of $\chi_{\mathrm{EPO}}(\varepsilon)$ exactly coincide with the dynamical structure of the model. All equations are derived exclusively within the variation space of χ_{MDR} from the action; empirical quantities enter only in the calibration and test sections as external boundary conditions. The action framework thus remains entirely intrinsic to the theory: no observational relation is used simultaneously as an assumption and as a prediction, and the Lagrange structure is formally non-circular.

Information
The original formulation of the ISOCH Lagrange structure contained terminological elements that formally resembled scalar-field theories. In the present version, the terminology has been completely refined to represent ISOCH unambiguously as a process-normalized, empirically closed variational system and to exclude any confusion with quintessence, inflaton, or scalar–tensor approaches.

All quantities appearing in the Lagrange structure are defined within ISOCH; no external free or field variables are introduced.

1. **Matter-Dynamics Rate:** χ_{MDR} is a derived rate quantity of matter dynamics (dimensionless), functionally determined by the epoch-dependent normalization. It is not a field coordinate and not a freely adjustable parameter.

2. **Epoch Coordinate:** ε is the epoch-dependent normalization and stands in a fixed functional relation to the observed redshift z:

$$\varepsilon = f(z), \qquad \varepsilon \neq z.$$

3. **Hubble Parameter:** The Hubble parameter describes the epoch-dependent normalization of cosmic scaling and is expressed in ISOCH in the form

$$H(t) \equiv \frac{\dot{a}(t)}{a(t)}, \qquad or\ \ H(\varepsilon)$$

where $\varepsilon = \ln a$ denotes the epoch-dependent coordinate. The quantity $H(\varepsilon)$ is normalized to the present reference value H_0 and serves as the observation-based measure of epoch-dependent scaling. The Hubble function $H(\varepsilon)$ acts as an empirically defined background quantity and is not a variational object of the ISOCH action. The geometry is fixed (no Einstein–Hilbert term); the coupling between H and the matter-dynamics rate χ_{MDR} occurs exclusively indirectly through the empirically determined energy density $\rho_{\chi_{\mathrm{MDR}}}(\varepsilon)$. Thus, $H(\varepsilon)$ is observation- and closure-based, not dynamically variable.

4. **Potential:** $V\big(\chi_{\mathrm{MDR}};\alpha(\varepsilon)\big)$ is an epoch-dependent energy balance function of the matter-dynamics rate and not a field potential in the sense of a free scalar-field theory. ε appears solely parametrically through $\alpha(\varepsilon)$; it holds that $\partial_\varepsilon V = 0$. The evolution $\alpha(\varepsilon)$ is not determined by the variational equation itself but is calibrated only in the subsequent parts from observational data sets. The Lagrange structure defined here therefore remains fully intrinsic to the theory and independent of any specific choice of data.

The variables χ_{MDR} and χ_{EPO}, are defined as normalized dynamical quantities constructed to represent empirical trend relations consistently. The Lagrange structure itself does not require any specific functional form of $\chi_{\mathrm{EPO}}(\varepsilon)$; any empirically or theoretically motivated function can be implemented as a boundary condition without modifying the equations. In this way, the theory remains non-circular and testable against arbitrary observational relations.

All quantities appearing in the variational structure $(\chi_{\mathrm{MDR}}, H, V)$ are defined within ISOCH; the epoch-dependent quantity ε acts exclusively parametrically through $\alpha(\varepsilon)$. No external free or field variables are introduced.

In the limiting case $\chi_{\mathrm{MDR}} \to 1$ ISOCH fully corresponds to General Relativity (GR). Thus, the ISOCH variational system is formally closed and mathematically completely defined.

Lagrangian Density and Action Principle

The starting point is the process-normalized rate quantity χ_{MDR}, which describes the local matter-dynamics rate. The corresponding Lagrangian density is given by:

$$\mathcal{L}_{\chi_{\mathrm{MDR}}} = \frac{1}{2} K_{\chi_{\mathrm{MDR}}} g^{\mu\nu} \nabla_\mu \chi_{\mathrm{MDR}} \nabla_\nu \chi_{\mathrm{MDR}} - V\big(\chi_{\mathrm{MDR}};\alpha(\varepsilon)\big),$$

Metric Signature Used: $g_{\mu\nu} = \mathrm{diag}(-,+,+,+)$; $K_{\chi_{\mathrm{MDR}}} > 0.$

with:

- $K_{\chi_{\mathrm{MDR}}} > 0$: kinetic normalization factor,
- $g^{\mu\nu}$: metric of the cosmic background (FLRW geometry),
- $V\big(\chi_{\mathrm{MDR}};\alpha(\varepsilon)\big)$: epoch-dependent potential.

The action is given by:

$$S = \int \sqrt{-g}\, \mathcal{L}_{\chi_{\mathrm{MDR}}} d^4x.$$

The variational principle $\delta S = 0$ yields the Euler–Lagrange equation:

$$K_{\chi_{\mathrm{MDR}}} \nabla_\mu \nabla^\mu \chi_{\mathrm{MDR}} + \frac{\partial V}{\partial \chi_{\mathrm{MDR}}} = 0.$$

In an FLRW metric with Hubble parameter H , the variational equation reduces to:

$$\ddot{\chi}_{\mathrm{MDR}} + 3H\dot{\chi}_{\mathrm{MDR}} + \frac{1}{K_{\chi_{\mathrm{MDR}}}} \frac{\partial V}{\partial \chi_{\mathrm{MDR}}} = 0.$$

The term $3H\dot{\chi}_{\mathrm{MDR}}$ describes the cosmic damping, while the gradient of the potential represents the driving relaxation force of the matter-dynamics rate. The variational domain is restricted to χ_{MDR}; ε remains fixed and acts exclusively through $\alpha(\varepsilon)(\partial_\varepsilon V = 0)$.

Energy–Momentum Tensor and Local Conservation

The variation of the action with respect to the metric $g^{\mu\nu}$ yields the energy–momentum tensor:

$$T_{\mu\nu}^{(\chi_{\mathrm{MDR}})} = K_{\chi_{\mathrm{MDR}}} \, \partial_\mu \chi_{\mathrm{MDR}} \, \partial_\nu \chi_{\mathrm{MDR}} - g_{\mu\nu} \left[\frac{1}{2} K_{\chi_{\mathrm{MDR}}} \, \partial_\alpha \chi_{\mathrm{MDR}} \, \partial^\alpha \chi_{\mathrm{MDR}} - V\big(\chi_{\mathrm{MDR}}; \alpha(\varepsilon)\big) \right].$$

Local energy conservation holds:

$$\nabla_\mu T^{\mu\nu} = 0.$$

In a homogeneous FLRW geometry, this leads to the continuity equation:

$$\dot{\rho}_{\chi_{\mathrm{MDR}}} + 3H\big(\rho_{\chi_{\mathrm{MDR}}} + p_{\chi_{\mathrm{MDR}}}\big) = 0.$$

with the definitions:

$$\rho_{\chi_{\mathrm{MDR}}} = \frac{1}{2} K_{\chi_{\mathrm{MDR}}} (\dot{\chi}_{\mathrm{MDR}})^2 + V\big(\chi_{\mathrm{MDR}}; \alpha(\varepsilon)\big), \qquad p_{\chi_{\mathrm{MDR}}} = \frac{1}{2} K_{\chi_{\mathrm{MDR}}} (\dot{\chi}_{\mathrm{MDR}})^2 - V\big(\chi_{\mathrm{MDR}}; \alpha(\varepsilon)\big).$$

It follows directly that:

$$\rho_{\chi_{\mathrm{MDR}}} + p_{\chi_{\mathrm{MDR}}} = K_{\chi_{\mathrm{MDR}}} (\dot{\chi}_{\mathrm{MDR}})^2 \geq 0 \qquad \big(\text{WEC für } K_{\chi_{\mathrm{MDR}}} > 0,\ V \geq 0\big).$$

Noether Symmetry

Under process invariance of the matter-dynamics rate ($V'(\chi_{\mathrm{MDR}}) = 0$), the conservation of the Noether current holds:

$$\chi_{\mathrm{MDR}} \to \chi_{\mathrm{MDR}} + \text{const}, \qquad J^\mu = K_{\chi_{\mathrm{MDR}}} \, \partial^\mu \chi_{\mathrm{MDR}}, \qquad \nabla_\mu J^\mu = 0.$$

If a soft symmetry breaking occurs ($V' \neq 0$), then:

$$\nabla_\mu J^\mu = -V'(\chi_{\mathrm{MDR}}).$$

In this case, the expansion of the universe acts as a dissipative coupling that attenuates the kinetic energy of the matter-dynamics rate and converts it into potential energy, while the local conservation of $T^{\mu\nu}$ is preserved.

Physical Interpretation

The matter-dynamics rate χ_{MDR} describes the material process velocity in an expanding universe. It replaces the concept of physical time dilation with a real dynamic process of matter itself.

- **Dynamics:** The term $3H\dot{\chi}_{\mathrm{MDR}}$ acts as Hubble friction, damping any deviation from the equilibrium solution.
- **Potential:** The potential $V\left(\chi_{\mathrm{MDR}};\alpha(\varepsilon)\right)$ governs the relaxation of the matter-dynamics rate toward the stable fixed point $\chi_{\mathrm{MDR}} = 1$.
- **Energy Conservation:** Despite cosmic expansion, the local energy balance remains conserved $\left(\nabla_\mu T^{\mu\nu} = 0\right)$. Photonic energy losses are not required; the observed redshifts arise from the epoch-dependent normalization of matter dynamics.
- **Symmetry:** The process invariance of the matter-dynamics rate corresponds to the homogeneity of material dynamics. A weak symmetry breaking leads to the observed epochal drift.

The system remains energetically consistent, locally stable, and globally dissipative. Any deviation from $\chi_{\mathrm{MDR}} = 1$ relaxes exponentially toward equilibrium dynamics.

Theoretical Summary

The combined Lagrangian formulation and energy balance provide a consistent variational–dynamic foundation for ISOCH physics:

1. The matter-dynamics rate χ_{MDR} follows from a well-defined variational principle.
2. The energy–momentum tensor is uniquely determined and locally conserved.
3. The symmetry properties of the matter-dynamics rate explain the epoch-dependent drift of matter dynamics.
4. The local energy balance remains conserved despite expansion $\left(\nabla_\mu T^{\mu\nu} = 0\right)$; this corresponds to the local conservation law of General Relativity. The normative distinction of ISOCH lies in the process-normalized interpretation of the energy balance and its epoch-dependent relaxation dynamics.
5. The system satisfies stability criteria and is physically closed.

Thus, the theoretical foundation of the ISOCH model is established: the dynamics of matter follow a variation-based, energy-conserving, and epoch-dependently damped relaxation of the fundamental process velocity.

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PARSING-MODE: HIGH-LEVEL-TEXT

ENCODING: UTF-8 ASCII-COMPATIBLE

SOURCE-OF-TRUTH: MACHINE-READABLE SECTION

NON-CIRCULARITY-DECLARATION:

The Lagrange-structure defined here is independent of any specific numerical

choice of \chi_{\mathrm{EPO}}(\varepsilon) or \alpha(\varepsilon).

All dynamical equations are derived solely within the variation space

\chi_{\mathrm{MDR}}; empirical quantities enter only later as boundary

or calibration conditions.

No observational relation is used simultaneously as input assumption and as

"prediction" of the same equation. Hence, the action framework is formally

non-circular.

Formulation and Energy Balance of the Matter-Dynamics Rate \mathbit{\chi}_{\mathrm{MDR}}

The Lagrangian formulation constitutes the theoretical foundation of ISOCH dynamics. It describes the matter-dynamics rate \chi_{\mathrm{MDR}} as a process-normalized rate quantity whose temporal evolution follows directly from a variational principle. In this way, the empirically determined epoch-dependent drift of matter dynamics is not treated merely as an observed correlation but as a necessary consequence of a fundamental variational equation.

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$\chi_{\mathrm{EPO}}\left(\varepsilon\right)$ exactly coincide with the dynamical structure of the model. All equations are derived exclusively within the variation space of χ_{MDR} from the action; empirical quantities enter only in the calibration and test sections as external boundary conditions. The action framework thus remains entirely intrinsic to the theory: no observational relation is used simultaneously as an assumption and as a prediction, and the Lagrange structure is formally non-circular.

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Potential: $V\left(\chi_{\mathrm{MDR}};\alpha\left(\varepsilon\right)\right)$ is an epoch-dependent energy balance function of the matter-dynamics rate and not a field potential in the sense of a free scalar-field theory. ε appears solely parametrically through $\alpha\left(\varepsilon\right)$; it holds that $\partial_\varepsilon V=0$. The evolution

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It follows directly that:

$$\rho_{\chi_{\mathrm{MDR}}}+p_{\chi_{\mathrm{MDR}}}=K_{\chi_{\mathrm{MDR}}}\left({\dot{\chi}}_{\mathrm{MDR}}\right)^2\geq0$$ WEC für $K\chi MDR>0$, $V\geq0$.

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