Dynamical reduction of quantum states and the Quantum / Gravitation interface

Daniel Sudarsky, ICN-UNAM. In colaborations: M. Castagnino (U. Buenos Aires, Arg.), R. Laura (U. Rosario, Arg.), H. Sahlman (U. Utrecht, Hol.), A. Perez (U. of Marseille Fr.), A. de Unanue (ICN- UNAM), G. Garcia (Trieste, It), P. Cañate (ICN-UNAM), A. Diez-Tejedor (U. Guanajuato, Mx.), S. Landau (U. Buenos Aires, Arg.) & C. Sccocola (Inst. Astr. Canarias, Sp.), Phillip Pearle (Hamilton College, EEUU)

QG in the Southren Cone , September , 2013

QUANTUM THEORY , THE MEASUREMENT PROBLEM & QUANTUM GRAVITY

i) Normally the evolution of a system S is controlled by the Hamiltonian $\hat{H}$ according to the deterministic Schrödinger equation:

$$i\frac{d|\xi\rangle}{dt} = \hat{H}|\xi\rangle \tag{1}$$

Such evolution is unitary.

ii) However upon a measurement of the observable $\hat{O}$ the system passes to a state $|o_n\rangle$ (corresponding to the eigenvalue o_n) :

$$|\xi\rangle \to |o_n\rangle \tag{2}$$

Such evolution is stochastic (with probability $P(o_n) = |\langle\xi|o_n\rangle|^2$).

BUT: What is a measurement ? That is : when exactly does the theory indicate the evolution should be according to i) (U Process) and when ii) (R Process)?

We have been influenced by R. Penrose who has been arguing that in joining quantum theory and gravitation, we might have to modify both and not just try to adapt gravitation to the general setting of QT.

Moreover in so doing we will need to resolve the measurement problem as that is essential in order to have a theory applicable to closed systems and in particular the universe as a whole.

It is worth noting that in combining QT and gravitational situations we have found (besides some severe mathematical difficulties) also some difficulties that seemed not to have counterparts in other cases:
1) The problem of Time in Canonical Quantum Gravity
2) The information loss paradox in BH evaporation processes.
Could it be that the resolution of these might come from following the path suggested by Penrose?

Some very preliminary analysis suggest a positive answer (Arxiv: gr-qc 1309.1730). However in this talk I want to focus on another problem:
3) The emergence of the seeds of structure from quantum fluctuations during the inflationary cosmological era.

2) Cosmological Inflation:

Inflation is a central aspect of contemporary cosmology : Basics: A

period of accelerated expansion predating the standard Hot Big Bang Scenario. Takes the universe from a relatively generic state after the Planck era to a state very well described (exponential in the number of e-folds) by a spatially flat Robertson Walker space-time

$$dS^2 = a(\eta)^2\{-d\eta^2 + dr^2 + r^2(d\theta^2 + Sen(\theta)^2 d\varphi^2\}$$

Advantages Resolves various naturalness problems: Flatness , Horizons , and GUT remnants.

The most important is the generation from " quantum fluctuations" of the seeds of cosmic structure

How exactly does this happen ? How, from quantum uncertainties do we end with actual inhomogeneities ?

STANDARD TREATMENT (single scalar field). Theory specified by the action:

$$S = \int d^4x\sqrt{-g}\{\frac{R}{16\pi G} + \nabla^{\mu}\phi\nabla_{\mu}\phi + V(\phi)\}$$

Consider a homogeneous and isotropic background as before ($FRW; K = 0$) and scalar field $\phi = \phi_0(\eta)$. Einstein's equations give:

$$3\mathcal{H}^2 = 4\pi G(\dot{\phi}_0^2 + 2a^2 V_0), \tag{3}$$

$\mathcal{H} \equiv \dot{a}/a$ where $"\cdot" = \frac{\partial}{\partial\eta}$. The scalar field satisfies the KG eq.:

$$\ddot{\phi}_0(\eta) - 2\dot{\phi}_0(\eta)\mathcal{H} + \frac{\partial V}{\partial\phi} = 0 \tag{4}$$

The classical background corresponds to a solution of these eqs. representing a "slow roll" condition.

On top of this one considers the perturbations:

$\phi(x) = \phi_0(\eta) + \delta\phi(\eta, \vec{x})$ con $\delta\phi(\eta, \vec{x}) \ll \phi_0(\eta)$

$$ds^2 = a^2(\eta)\left[-(1+2\psi)d\eta^2 + (1-2\psi)\delta_{ij}dx^i dx^j\right], \quad \text{con} \quad \psi(\eta, \vec{x}) \ll 1. \tag{5}$$

Describe the perturbations ($\delta\phi$ & ψ) in terms of new variables :

$$u \equiv \frac{a\psi}{4\pi G\dot{\phi}_0}, \quad v \equiv a\left(\delta\phi + \frac{\dot{\phi}_0}{\mathcal{H}}\psi\right), \tag{6}$$

One then proceeds to the quantization of the perturbations in the usual QFT in CS manner:

$$\hat{v}(x, \eta) = \sum_{\vec{k}}\left(\hat{a}_{\vec{k}} v_{\vec{k}}(\eta) e^{i\vec{k}.\vec{x}} + \hat{a}^\dagger_{\vec{k}} v^*_{\vec{k}}(\eta) e^{-i\vec{k}.\vec{x}}\right), \tag{7}$$

Evaluating the two point function in the BD vacuum, $\langle 0|\hat{v}(x, \eta)\hat{v}(y, \eta)|0\rangle$ one extracts the “Power spectrum”:

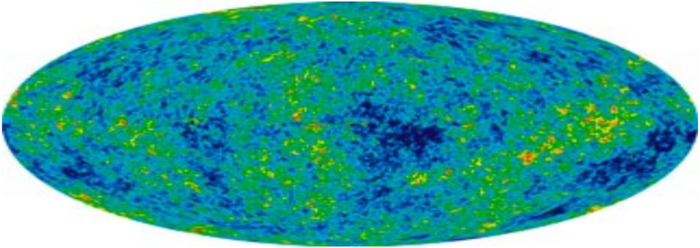
$$\langle 0|\hat{v}(x, \eta)\hat{v}(y, \eta)|0\rangle = \int d^3k e^{ik(x-y)} P(k)/k^3. \tag{8}$$

The observations

We see the CMB photons emitted at the (LSS) with a local temperature $T \approx 3000K^0$. subject to two redshifts : 1) That tied to the overall cosmological expansion leading to $T \approx 2.7K^0$. 2) That tied to the exiting from the local Newtonian potential well, tied to the local matter distribution (there are more complexities but this is enough for our purposes).

Thus $\frac{\delta T}{T_0}(\theta, \varphi) = \frac{1}{3}\psi(\eta_D, \vec{x}_D)$: characterizes the Newtonian Potential on the intersection of our past light cone with the LSS.

060913_320.jpg 320×160 píxeles



This map is characterized using an expansion in spherical harmonics: $\frac{\delta T}{T_0}(\theta, \varphi) = \sum_{lm} \alpha_{lm} Y_{lm}(\theta, \varphi)$.

Thus the coefficients

$$\alpha_{lm} = \frac{1}{3} \int d\Omega^2 \psi(\eta_D, \vec{x}_D) Y^*_{lm}(\theta, \varphi) \tag{9}$$

The determination of $\frac{\delta T}{T_0}(\theta, \varphi)$ provides the map from where one extracts the α_{lm}.

Most studies focus on:

$$C_l = \frac{1}{2l+1} \sum_m |\alpha_{lm}|^2. \tag{10}$$

everything seems to work fine.
But if we look at

$$\alpha_{lm} = \frac{1}{3} \int d\Omega^2 \langle 0|\psi(\eta_D, \vec{x}_D)|0\rangle Y^*_{lm}(\theta, \varphi) = 0. \tag{11}$$

Why trust one prediction and not this one?

2) USUAL ANSWERS:

a) We make measurements, thus inducing the reduction of the quantum state . But we are here in part as the result of those inhomogeneities.

b) Correlations?. They do not imply a breakdown of the symmetry before measurements (think EPR-b).
c)Decoherence: environments + MANY WORLD Interpretation (MWI).

i) Requires identification of the D.O.F that act as “environment”. Implies using our experimental limitations as part of the argument.
ii) Decoherence does not imply the situation corresponds to one of the elements on the decohereing (diagonal) density matrix. Seems to require MWI
iii) However a close examination of MWI indicates the reliance on some brain whose states of consciousness determine the BASIS characterizing the world splitting.
d) Consistent Histories The answers depend on the way we ask the questions.

3) If the known physics is unable to resolve the problem we must consider new physics

NOTE: This is the only situation where we find the combination :

Quantum Theory + General Relativity + Observations .

We need to be able to point to a physical process taking place in time and able to explain the emergence of the seeds of cosmic structure. "Emergence " refers to : something that was not there initially being there at a later time .

We propose : adding to the inflationary paradigm some spontaneous dynamical collapse of the quantum state. (Inspired on ideas of Penrose/ Diosi).

Dynamical Collapse Theories : GRW, Pearle, Diosi, Penrose & recently Weinberg.

Example, CSL: It is defined by two equations:
A modified Schrödinger equation, whose solution is:

$$|\psi, t\rangle_w = \hat{\mathcal{T}} e^{-\int_0^t dt' \left[i\hat{H} + \frac{1}{4\lambda}[w(t') - 2\lambda\hat{A}]^2 \right]} |\psi, 0\rangle. \quad (12)$$

($\hat{\mathcal{T}}$ is the time-ordering operator). $w(t)$ is a random classical function of time, of white noise type, whose probability is given by the second equation, the Probability Rule:

$$PDw(t) \equiv {}_w\langle\psi, t|\psi, t\rangle_w \prod_{t_i=0}^{t} \frac{dw(t_i)}{\sqrt{2\pi\lambda/dt}}. \quad (13)$$

The processes U and R (corresponding to the observable $\hat{A}$) are unified. For the case of non-relativistc QM the proposal assumes : $\hat{A} = \hat{\vec{X}}$.

The parameter λ must be small enough not to conflict with many tests of QM in the domain of subatomic physics and big enough to result in rapid localization of macroscopic objects. GRW suggested range: $\lambda \sim 10^{-16} sec^{-1}$. (Likely depends on particle mass).

4) Our approach :

We need to adapt the approach to situations involving both Quantum Fields and gravitation.

In order to incorporate a dynamical reduction in the quantum state we need the notion of " time" (the collapse takes place in time). As QG has this problem and its resolution generically involves passing to a sort of semiclassical regime. We make our analysis assuming we can rely on a semiclassical framework.
We consider that even if at the deepest levels gravitation must be quantum mechanical in nature at the meso/macro scales, it corresponds to an emergent phenomena, with traces of the quantum regime surviving in the form of an effective dynamical state reduction for matter fields (here we are following to a certain extent Penrose & Diosi's ideas).

Accordingly we assume that in the inflationary regime one already has a good description of gravitation in terms of classical geometric notions but of course matter fields must still be considered using quantum theory . This seems reasonable as inflation is supposed to occur at scales where $R << 1/l^2_{Planck}$.

The space-time is treated classically (in our case using a specific gauge and ignoring tensor perturbations):

$$ds^2 = a^2(\eta)\left[-(1+2\Psi)d\eta^2 + (1-2\Psi)\delta_{ij}dx^i dx^j\right], \Psi(\eta,\vec{x}) \ll 1$$

The scale factor can be written as

$$a(\eta) = \frac{-1}{\eta H_I} \tag{14}$$

with $\eta \in (\mathcal{T}, \eta_0), \eta_0 < 0$.

The scalar field must be treated using QFT in CS .

The quantum state of the scalar field and the space-time metric satisfy Einstein's semiclassical eq.

$$G_{\mu\nu} = 8\pi G\langle\xi|\hat{T}_{\mu\nu}|\xi\rangle.$$

We will be concentrating on the modes other than the zero mode which is responsible for the overall inflationary expansion and which we treat classically as an effective approximation.

At the early stages of inflation which we denote by $\eta = -\mathcal{T}$, the state of the scalar field perturbation is described by the Bunch-Davies vacuum, and the space-time is 100 % homogeneous and isotropic.

In fact in the vacuum state the operators $\hat{\delta}\phi_k$ $\hat{\pi}_k$ are characterized by gaussian wave functions centered on 0 with uncertainties $\Delta\delta\phi_k$ and $\Delta\pi_k$.

The collapse modifies the quantum state, and generically the expectation values of $\delta\hat{\phi_k}(\eta)$ and $\hat{\pi}_k(\eta) = \frac{\partial\delta\hat{\phi_k}(\eta)}{\partial\eta}$.

We must now specify the rules governing the collapse. This is the result of some unknown aspect of physics, which we will here encode into a CSL theory . The approach is based on making an "educated guess", which can later be contrasted with observations. The collapse will be controlled mode by mode by a stochastic function.

Our universe would correspond to one specific realization of these stochastic functions (one for each $\vec{k}$).

The semi classical Einstein Equation we must focus on is:

$$-k^2\Psi(\eta,\mathbf{k}) = 4\pi G\phi_0'(\eta)\langle\hat{\delta\phi}'(\mathbf{k},\eta)\rangle = \frac{4\pi G\phi_0'(\eta)}{a}\langle\hat{\pi}(\mathbf{k},\eta)\rangle \tag{15}$$

($\langle\hat{\pi}(\mathbf{k},\eta)\rangle \equiv \langle\psi,\eta|\hat{\pi}(\mathbf{k})|\psi,\eta\rangle$). As we said at the start of inflation($\eta = -\mathcal{T}$) state is described by the Bunch-Davies vacuum, so $\langle\psi,-\mathcal{T}|\hat{\pi}(\mathbf{k})|\psi,-\mathcal{T}\rangle = 0$, and THUS as long as the state of the field is that vacuum the space-time WILL BE 100% homogeneous and isotropic.

$$\frac{\Delta T(\theta,\varphi)}{\bar{T}} = c\int d^3k e^{i\mathbf{k}\cdot\mathbf{x}}\frac{1}{k^2}\langle\hat{\pi}(\mathbf{k},\eta)\rangle, \text{ where } c \equiv -\frac{4\pi G\phi_0'(\eta)}{3a}. \tag{16}$$

Here, $\mathbf{x}$ is a point on the intersection of our past light cone with the last scattering surface. Corresponds to the direction on the sky specified by θ,φ.Thus:

$$\alpha_{lm} = c\int d^2\Omega Y^*_{lm}(\theta,\varphi)\int d^3k e^{i\mathbf{k}\cdot\mathbf{x}}\frac{1}{k^2}\langle\hat{\pi}(\mathbf{k},\eta)\rangle. \tag{17}$$

There is no analogous to this expression in the standard approaches!

The eq. above shows that the quantity of interest can be thought of as a result of a random walk on the complex plane. One can predict the end point but can focus on the magnitude of the total displacement:

$$|\alpha_{lm}|^2 = (4\pi c)^2 \int d^3k d^3k' j_l(kR_D) j_l(k'R_D) Y_{lm}(\hat{k}) Y^*_{lm}(\hat{k}') \tag{18}$$

$$\frac{1}{k^2k'^2}(\langle\hat{\pi}(\mathbf{k},\eta)\rangle\langle\hat{\pi}(\mathbf{k}',\eta)\rangle^*). \tag{19}$$

and estimate the value by an ensemble average. Thus we compute the ensemble average at "late times"

$\overline{(\langle\hat{\pi}(\mathbf{k},\eta)\rangle\langle\hat{\pi}(\mathbf{k}',\eta)\rangle^*)} = f(k)\delta(\mathbf{k}-\mathbf{k}')$.

Then,

$$\overline{|\alpha_{lm}|^2} = (4\pi c)^2 \int_0^\infty dk j_l(kR_D)^2 \frac{1}{k^2} f(k). \tag{20}$$

Now we need to use the theory controlling the Collapse.

As we said we will here consider CSL. We still need to chose the operator $\hat{A}$ driving the collapse and the parameter λ.

We work with a rescaled field $y(\eta,\vec{x}) \equiv a\delta\phi(\eta,\vec{x})$ and its momentum conjugate $\pi_y(\eta,\vec{x}) = a\delta\phi'(\eta,\vec{x})$.

For simplicity, put everything in a Box of size L (to be removed at the end), and focus on a single mode $\vec{k}$, so we write:

$$X \equiv (2\pi/L)^{3/2} y(\eta,\vec{k}), \qquad P \equiv (2\pi/L)^{3/2} \pi_y(\eta,\vec{k}). \tag{21}$$

As we saw, in order to compare with the observations, we need to evaluate the ensemble average $\overline{\langle\hat{P}\rangle^2}$, and determine under what circumstances, if any, this is $\sim k$.

$\hat{P}$ as Generator of Collapse Set $\hat{A} = \hat{P}$.
we obtain

$$\overline{\langle \hat{P} \rangle^2} = \frac{\lambda k^2 \mathcal{T}}{2} + \frac{k}{2} - \frac{k}{\sqrt{2}\sqrt{1+\sqrt{1+4\lambda^2}}}. \tag{22}$$

Note that if we set $\lambda = 0$ (turn off CSL), we have the standard quantum mechanics result $\overline{\langle \hat{P} \rangle^2} = 0$ since $\langle \hat{P} \rangle = 0$.
We see that agreement with the observed scale-invariant spectrum,is achieved if we assume the first term is dominant and we set

$$\lambda = \tilde{\lambda}/k. \tag{23}$$

We note that this replaces the dimensionless collapse rate parameter λ with parameter $\tilde{\lambda}$ of dimension time $^{-1}$.

In that case we obtain:

$$\overline{\langle \hat{P} \rangle^2} = \frac{\tilde{\lambda} k \mathcal{T}}{2} + \frac{k}{2} - \frac{k}{\sqrt{2}\sqrt{1+\sqrt{1+4(\tilde{\lambda}/k)^2}}}. \tag{24}$$

$\hat{X}$ as Generator of Collapse Set $\hat{A} = \hat{X}$

In this case we obtain

$$\overline{\langle \hat{P} \rangle^2} = \frac{\lambda \mathcal{T}}{2} + \frac{k}{2} \otimes \tag{25}$$

$$[1 - \frac{(1+4(\lambda/k^2)^2)}{F(\lambda/k^2) + 2(\lambda/k^2)^2 F^{-1}(\lambda/k^2) - 2(\lambda/k^2)(k\eta)^{-1}}]. \tag{26}$$

where $F(x) \equiv \frac{1}{\sqrt{2}}\sqrt{1+\sqrt{1+4x^2}}$.

Once more, if we turn off CSL, $\lambda = 0$ we find $\overline{\langle \hat{P} \rangle^2} = 0$.

We see that agreement with the observed scale-invariant spectrum, $\overline{\langle\hat{P}\rangle^2} \sim k$, can be achieved if we assume that the first term dominates, and if we set

$$\lambda = \tilde{\lambda}k. \tag{27}$$

This replaces the collapse rate parameter λ of dimension time $^{-2}$ with the parameter $\tilde{\lambda}$ of dimension time $^{-1}$. In that case we obtain:

$$\overline{\langle\hat{P}\rangle^2} = \frac{\tilde{\lambda}k\mathcal{T}}{2} + \frac{k}{2}[1 - \frac{(1 + 4(\tilde{\lambda}/k)^2)}{F(\tilde{\lambda}/k) + 2(\tilde{\lambda}/k)^2 F^{-1}(\tilde{\lambda}/k) - 2(\tilde{\lambda}/k)(k\eta)^{-1}}]. \tag{28}$$

Comparison with observations, using GUT scale inflation potential value and slow-roll parameter (order a few percent), we estimate $\lambda \sim 10^{-5} MpC^{-1} \approx 10^{-19} sec^{-1}$. Not very different from GRW suggestion .

Collapse on Field Operators

We would like to understand how the collapse looks when described in terms of the space-time field operators. In one case we can start by defining

$$\tilde{y}(\mathbf{x}) \equiv \frac{1}{(2\pi)^{3/2}} \int d\mathbf{k} e^{i\mathbf{k}\cdot\mathbf{x}} k^{1/2} y(\mathbf{k}) = (-\nabla^2)^{1/4} \hat{y}(\mathbf{x}), \qquad (29)$$

The state vector evolution given by

$$|\psi, t\rangle = \mathcal{T} e^{-i\int_{-\mathcal{T}}^{\eta} d\eta' \hat{H} - \frac{1}{4\tilde{\lambda}} \int_{-\mathcal{T}}^{\eta} d\eta' \int d\mathbf{x} [w(\mathbf{x}, \eta') - 2\tilde{\lambda}\tilde{y}(\mathbf{x})]^2} |\psi, -\mathcal{T}\rangle. \qquad (30)$$

This is just the standard CSL statevector evolution, where the collapse-generating operators (toward whose joint eigenstates collapse tends) are $\tilde{y}(\mathbf{x})$ for all $\mathbf{x}$.

Similarly, in the other case,

$$|\psi,\eta\rangle = \mathcal{T}e^{-i\int_{-\mathcal{T}}^{\eta}d\eta'\hat{H}-\frac{1}{4\tilde{\lambda}}\int_{-\mathcal{T}}^{\eta}d\eta'\int d\mathbf{x}'[w(\mathbf{x}',\eta')-2\tilde{\lambda}\tilde{\pi}(\mathbf{x}')]^2}|\psi,-\mathcal{T}\rangle. \quad (31)$$

where $\tilde{\pi}(\mathbf{x}) \equiv (-\nabla^2)^{-1/4}\hat{\pi}(\mathbf{x})$.
This is just the standard CSL state-vector evolution, where the collapse-generating operators (toward whose joint eigenstates collapse tends) are $\tilde{\pi}(\mathbf{x})$ for all $\mathbf{x}$.

What are the fundamental reasons determining the appearance of the operators $(-\nabla^2)^{-1/4}\hat{\pi}(\mathbf{x})$ (or $(-\nabla^2)^{1/4}\hat{y}(\mathbf{x})$)

A satisfactory answer will have to wait for a general theory expressing, in all situations, from particle physics to cosmology, the exact form of the CSL-type of modification to the evolution of quantum states.

6) OTHER STUDIES & PREDICTIONS.

i) No tensorial modes (at 1-st order pert theory, semiclassical)

ii) Approach could offer a solution to the ”Fine Tuning” problem for the inflationary Potential. (CQG, 27, 225017, (2010).

iii) Multiple Collapses . More information about post collapse states. Limits on number of collapses per mode (CQG, 28, 155010, (2011))

iv) Novel options for the analysis of No-Gaussianities (*Sigma* **8**, 024, (2012) & *PRD* in press. e-Print: arXiv:1107.3054)

v) Development of the SSC formalism that incorporates dynamical collapses in the semi-classical GR setting *JCAP*. **045**, 1207, (2012))

vi) Use of a version of CSL to the cosmological problem: *PRD* , **87**, 104024 (2013)

vii)Speculative ideas on connections to QG, and to the problem of time: Wheeler de Witt or LQG are atemporal theories. Time recovered by identifying observables that act as physical clocks. The evolution presented in terms of such variables $\rightarrow$ modified Schrödinger eq. that is not 100% unitary. Is related to what we describe (within the spatio-temporal framework) as collapse?

JUMP

In the formal level we rely on the notion of *Semiclassical Self-consistent Configuration* (SSC).

DEFINITION: The set $g_{\mu\nu}(x), \hat{\varphi}(x), \hat{\pi}(x), \mathcal{H}, |\xi\rangle \in \mathcal{H}$ represents a SSC off $\hat{\varphi}(x)$, $\hat{\pi}(x)$ y $\mathcal{H}$ corresponds to QFT in CS over the space-time with métrica $g_{\mu\nu}(x)$, and MOREOVER the state $|\xi\rangle$ in $\mathcal{H}$ is such that:

$$G_{\mu\nu}[g(x)] = 8\pi G\langle\xi|\hat{T}_{\mu\nu}[g(x), \hat{\varphi}(x), \hat{\pi}(x)]|\xi\rangle.$$

In order to describe the transition from a H&I situation to one that is not, we need a collapse, however it must be described as a transition for one complete SSC to another one. That is , we do not have simple jumps in states but jumps of the form $....SSC1.... \rightarrow ....SSC2....$

This involves change in the quantum state, wick requires a change in the space-time metric , and with in turn requires a change in the Hilbert space to which the state can belong. We have downs this in a single mode single collapse case. In practice we will ignore some of the complications needed to do this strictly.

Beware of the unjustified identification of different kinds of averages : (quantum expectation values , averages over classical ensembles averages on a single system over time (ergodicity / equilibrium), or space or orientation, ..).

The state of the system is that characterized by $\hat{a}_{\vec{k}}|0\rangle = 0$, and is thought to accurately characterize the situation after a few inflation "e-folds" (up to irrelevant remanent inhomogeneities of order e^{-N})

In other words the exponential expansion drives the geometry and all matter fields to a very simple state which is in particular, highly symmetric (homogeneous and isotropic).

In fact one can easily check the state $|0\rangle$ is completely Homogeneous and Isotropic.

Proof The generator of spatial translations is : $\hat{\vec{P}} = \sum_{\vec{k}} \vec{k}\, \hat{a}^{\dagger}_{\vec{k}}\, \hat{a}_{\vec{k}}$. thus the finite translation given by $\vec{D}$, leave the quantum state unchanged :

$$e^{i\vec{D}\hat{\vec{P}}}|0\rangle = |0\rangle \ .$$

(analogously for the isotropy).

These primordial inhomogeneities that seed all the structure in the Universe: (galaxies, stars, planets , and in the end life and humans)

Theory and observations fit very nicely.
However: The universe according to these ideas was H&I, (both at the level that an be described classically and also at the quantum level) as a result of inflation however we end up describing a situation that contains the primordial inhomogeneities.

How can this occur if the dynamics of the closed system does not break such symmetries?

It is natural to expect that a theory that explains the emergence of primordial inhomogeneities, should account for such dynamic change in the symmetry.