Tensorial Bio-Spectral Stability Theorem

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Tensorial Statement

Theorem (Tensorial Bio-Spectral Stability). *A molecular structure (molecule or protein) is stable if and only if its atomic configuration $\vec{R} = \{\vec{r}_1, \ldots, \vec{r}_N\}$ aligns with the rigidity nodes of a tesseract, and the angular defect $\delta = 0$, satisfying the global minimum condition of the energy functional $E[\vec{R}]$.*

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1 Tensorial Energy Functional

The total energy is defined as:

$$E[\vec{R}] = \sum_{i<j} V_b(\|\vec{r}_i - \vec{r}_j\|) + \sum_{i<j<k<l} R_{ijkl}(\vec{r}_i, \vec{r}_j, \vec{r}_k, \vec{r}_l) + \sum_{i<j<k} V_t(\theta_{ijk}) \tag{1}$$

where:

- V_b is the bond potential (distance-dependent).
- V_t is the torsion potential, with θ_{ijk} the angle between consecutive atoms:

$$\theta_{ijk} = \arccos \frac{(\vec{r}_i - \vec{r}_j) \cdot (\vec{r}_k - \vec{r}_j)}{\|\vec{r}_i - \vec{r}_j\| \, \|\vec{r}_k - \vec{r}_j\|}$$

- R_{ijkl} is the **rigidity tensor** encoding the system's response to deviations from internal and boundary nodes (5 zeros).

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2 Tensorial Node Rigidity Condition

For each segment connecting atoms, the tensor R_{ijkl} ensures that deviations ϵ_m increase the energy at second order:

$$\Delta E = \frac{1}{2} \sum_{i,j,k,l} R_{ijkl} \, \epsilon_i \epsilon_j \epsilon_k \epsilon_l + \mathcal{O}(\epsilon^5) \tag{2}$$

The nodes are:

- **Boundary zeros:** coincide with atomic nuclei (i, j).
- **Interior zeros:** critical electronic density nodes (k, l).

This guarantees a **rigid configuration**, minimal under small fluctuations.

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3 Hopf Angles and Golden Ratio

Amino acids follow the 5-zero rule with Hopf rotation matrix $R(\theta_H)$ and golden ratio ϕ:

$$\vec{r}_{n+1} = \phi\, R(\theta_H) \cdot \vec{r}_n \tag{3}$$

where $\theta_H \approx 137.036^\circ$ and $R(\theta_H) \in SO(3)$.
The torsion angles satisfy:

$$\Theta_{ijk} = \theta_H \quad \forall (i, j, k) \in \text{polypeptide chain} \tag{4}$$

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4 Global Minimum Condition

Stability requires the tensorial functional to be at a global minimum with respect to all coordinates:

$$\frac{\partial E[\vec{R}]}{\partial \vec{r}_i} = 0, \quad \frac{\partial^2 E[\vec{R}]}{\partial \vec{r}_i \partial \vec{r}_j} \succ 0, \quad \forall i, j = 1, \ldots, N \tag{5}$$

where the Hessian defined by R_{ijkl} must be **positive definite**, ensuring a stable minimum.

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5 Tensorial Conclusion

A molecule is stable if and only if:

$$\delta = 0, \quad Z(\vec{R}) = 0, \quad E[\vec{R}] = \min \tag{6}$$

Proteins automatically compute their shape following the zeros of the tensor R_{ijkl}, Hopf torsion angles θ_H, and golden ratio ϕ, ensuring **rigidity and structural invariance**.

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