Origin of Gamma-ray Bursts:

Galactic Seed Separation – ECT

Version-2022.01

Gamma-ray bursts were released in **separation** of a **galactic seed.**

Gamma-ray burst (GRB):

- Emits enormous energies during a short period (10 ms to 100 s).
- Observed from almost all regions except for the milky way and its neighbor.
- Current proposed origins:

  Short GRBs (< 2s): Merger of binary neutron stars (or with a blackhole)

  Long GRBs (> 2s): Collapsar model

  With supernova explosion, a massive star collapses to a blackhole. The fall of material into a blackhole derives relativistic jets, which hit the stellar envelope and radiate gamma-ray.

- Long GRBs are often associated with an afterglow.

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Inconsistent features of GRBs to the models:

1) No longer emitted since 130 million years ago. Should happen in the milky way and near galaxies by the models.
2) Only a little portion of long GRBs are associated with a supernova. It is a hyper-luminous one. Is it a supernova derived from a star?
3) Associated supernova is delayed by about one day from the initial GRB. Should be simultaneous or prior by the model.
4) The energy is too high, around a level of a galaxy. The origin should not be a star.

According to the energy circulation theory (ECT):

- Blackhole does not exist.

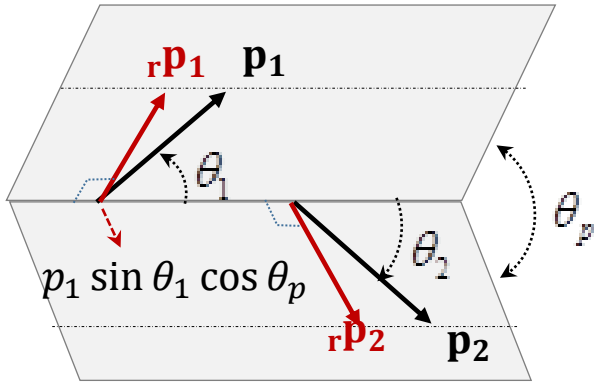
  Before a gravitational collapse, a continuous energy circulation is formed by the fundamental force working on momentums. What is said to be a blackhole is a galactic seed or a stellar seed.

- A galactic separation to two seeds shows a decrease in the potential energy, which can be released as an energy radiation.

< Fundamental force >

Fundamental force:

- Works based on momentums. $_{\mathrm{r}}\mathbf{p}$: orthogonal component to distance dir.
- Positive force is repulsive, and negative one is attractive.
- Electric, magnetic and nuclear forces are its presentations.



$$F = K_f \frac{{}_{\mathrm{r}}\mathbf{p_1} \cdot {}_{\mathrm{r}}\mathbf{p_2}}{d^2} = K_f \frac{p_1 p_2}{d^2} \cos\theta_p \sin\theta_1 \sin\theta_2$$

K_f: Fundamental force constant

Intra-circulation force:

$$F = K_f \frac{\Delta p_0 \Delta p_\theta}{d^2} \sin\frac{\theta}{2} \sin\frac{-\theta}{2} = -K_f \frac{\Delta p_0 \Delta p_\theta}{4\mu^2}$$

Sum of local forces on Δp_0 with the whole circumference:

$$cF_\perp = -K_f \frac{p\Delta p_0}{2\pi\mu^2} = -K_f \frac{E\Delta E}{2\pi {V_c}^2 \mu^2} = -K_f {V_c}^2 \frac{Mm}{2\pi\mu^2}$$

< Generation of galactic seeds from the initial universe >

Cosmic separation to two universes (1D separation)

Two pairs of conjugate circulations in X_1-X_2 and in X_3-X_4 $\Longrightarrow$ decoupled

$$E\mu(\varphi_{12}+\varphi_{12}^*)(\varphi_{34}+\varphi_{34}^*) \Longrightarrow \frac{E}{2}\mu\varphi_{12}\varphi_{34}+\frac{E}{2}\mu\varphi_{12}^*\varphi_{34}^*\,, \qquad \varphi=\exp(i\omega t)$$

Energy location of our universe by 4D polar system:

$$\mathbf{x}=[\mu_U \quad \theta_1 \quad \theta_2 \quad \theta_3\,]=[\mu_U \quad \omega t \quad \theta_2 \quad \omega t\,]$$

By 4D Cartesian coordinates:

$$\mathbf{x}=\mu_U(\cos\omega t+i\sin\omega t\cos\theta_2+j\sin\omega t\sin\theta_2\cos\omega t+k\sin\omega t\sin\theta_2\sin\omega t)$$

Take base vectors $\mathbf{e_0}$ for radius and $\mathbf{e_1}$ for arc of the circulation in $\mu_U\theta_1$.

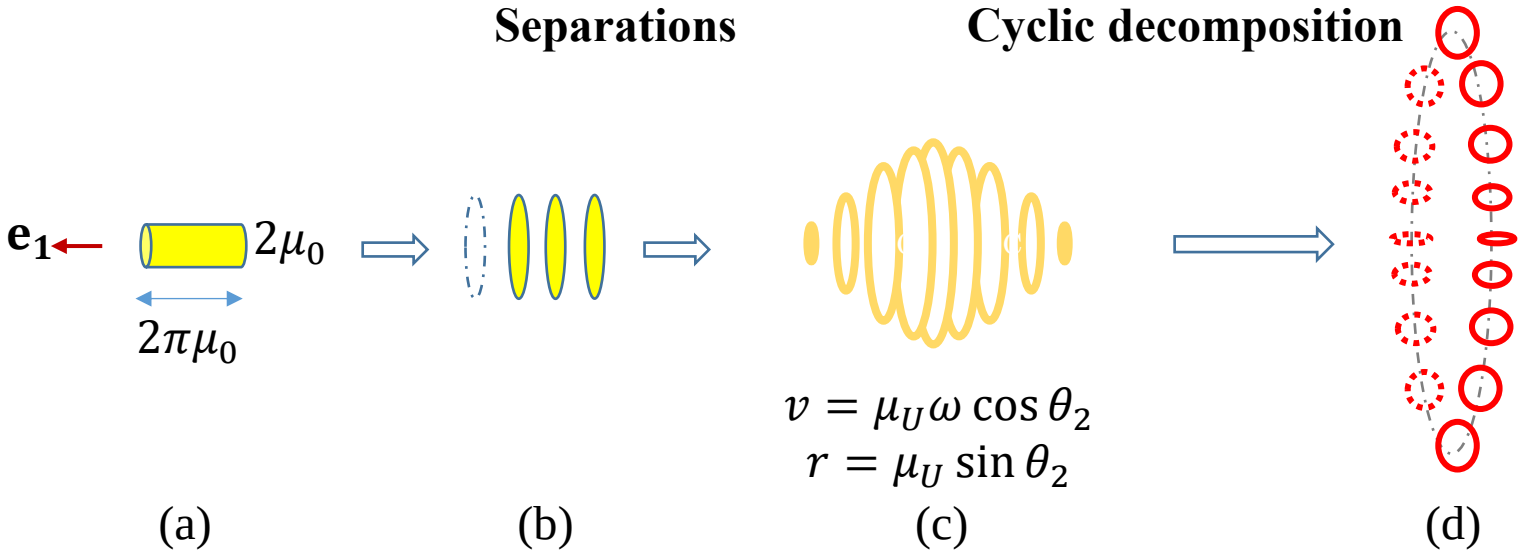
$$\mathbf{e_0}\equiv\cos\theta_1+i\sin\theta_1$$

$$\mathbf{e_1}\equiv\cos(\theta_1+\pi/2)+i\sin(\theta_1+\pi/2)=-\sin\theta_1+i\cos\theta_1=i\mathbf{e_0}$$

By 3D Cartesian coordinates using $\mathbf{e_1}$ orthogonal to j and k:

$$\mathbf{x}=\mu_U\big(\omega t\mathbf{e_1}\cos\theta_2+\sin\theta_2\,(j\cos\omega t+k\sin\omega t)\big)$$

Early cosmic evolution with space expansion:

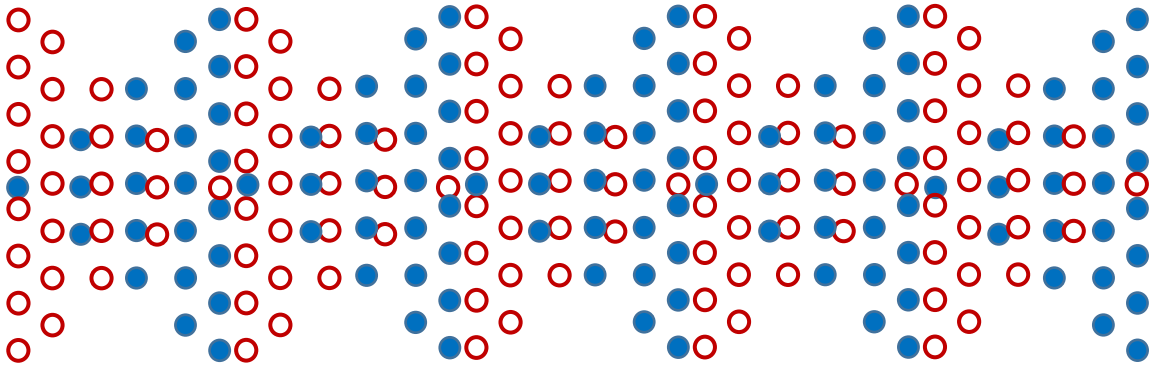


Separations and cyclic decomposition of the initial apparent energy

(a) Two ends are connected in $\mathbf{e_1}$-$\mathbf{e_0}$. (b) Separates to plural discs. (c) Each disc separates to plural circulations (different velocities / radiuses). (d) Each circulation decomposes to local circulations (**cyclic decomposition**)

Cyclic decompositions repeat in plural rounds with space expansion.

A huge number of energy circulations = **galactic seeds**



Large-scale distribution of energy circulations corresponding to clusters or superclusters of galaxies. The helicity of filled circles is left-handed and that of open circles is right-handed.

$$0 < \theta_2 < \pi/2 : \quad v > 0 \ (\text{left} - \text{handed})$$
$$\pi/2 < \theta_2 < \pi : \quad v < 0 \ (\text{right} - \text{handed})$$

By a cyclic decomposition, the helicity is inherited in daughter circulations. Asymmetries in distribution and helicity are preserved in current galaxies.

Recently observations reported:

- Large scale rotations of galactic superclusters.
- Asymmetric spin distribution of galaxies, indicating a cosmic rotation.
- Helical motion of galaxies in filaments of clusters.

< Interactions between conjugate circulations $S - \overline{S}$ >

Orthogonal interaction:

$$F_{ort}(S-\overline{S}) = K_f \frac{{p_h}^2}{\pi {\mu_0}^2}\left(\frac{x}{(x^2+1)^{3/2}} - \frac{1}{x^2}\right)$$

K_f: fundamental force constant for intrinsic energies moving at $c = \mu_0\omega_0$

p_h: half-circle momentum $p_h \equiv m_0 v_c/2 = m_0\mu_0\omega_0/2$

x : relative distance to the diameter given by $x \equiv d/2\mu_0$.

At $x = x_0$, micro-circulations are formed.

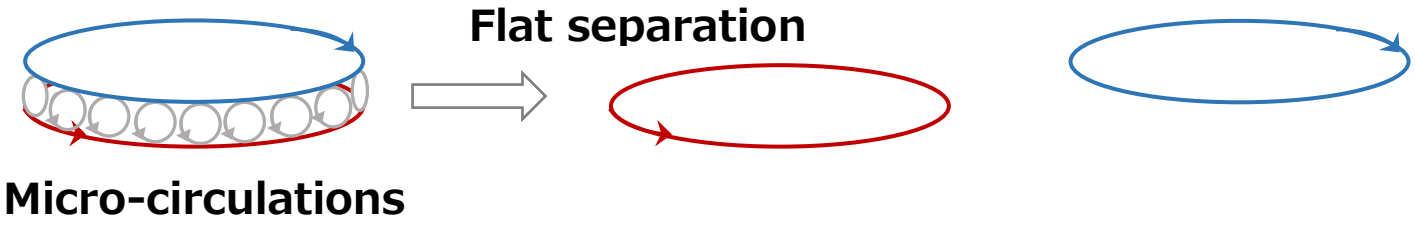
Flat interaction:

$$F_{flat}(S-\overline{S})$$

$$= K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2}\left(\frac{x-1}{((x-1)^2+{x_0}^2)^{3/2}} + \frac{x+1}{((x+1)^2+{x_0}^2)^{3/2}} - \frac{2x}{(x^2+{x_0}^2)^{3/2}}\right)$$

(Approximation is used. For derivation, refer to Quamtum Particles based on ECT)

Micro-circulations and Flat separation:



(a) Conjugate pair (b) Flat separation of two circulations

Flat separation of conjugate energy circulations. Coupled circulations form micro-circulations. The main circulations slide with keeping the orthogonal distance as the diameter of micro-circulations.

< Interactions between same-directional circulations $S-S$ >

Flat interaction:

$$F_{flat}(S-S) = -F_{flat}\left(S-\overline{S}\right)$$
$$= K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2}\left(\frac{2x}{(x^2+{x_0}^2)^{3/2}} - \frac{x-1}{((x-1)^2+{x_0}^2)^{3/2}} - \frac{x+1}{((x+1)^2+{x_0}^2)^{3/2}}\right)$$

$$Q_P \equiv K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2}$$

$$f_{flat}(x) \equiv \frac{2x}{(x^2+{x_0}^2)^{3/2}} - \frac{x-1}{((x-1)^2+{x_0}^2)^{3/2}} - \frac{x+1}{((x+1)^2+{x_0}^2)^{3/2}}$$

$$F_{flat}(S-S) = Q_P f_{flat}(x)$$

Orthogonal interaction for large x:

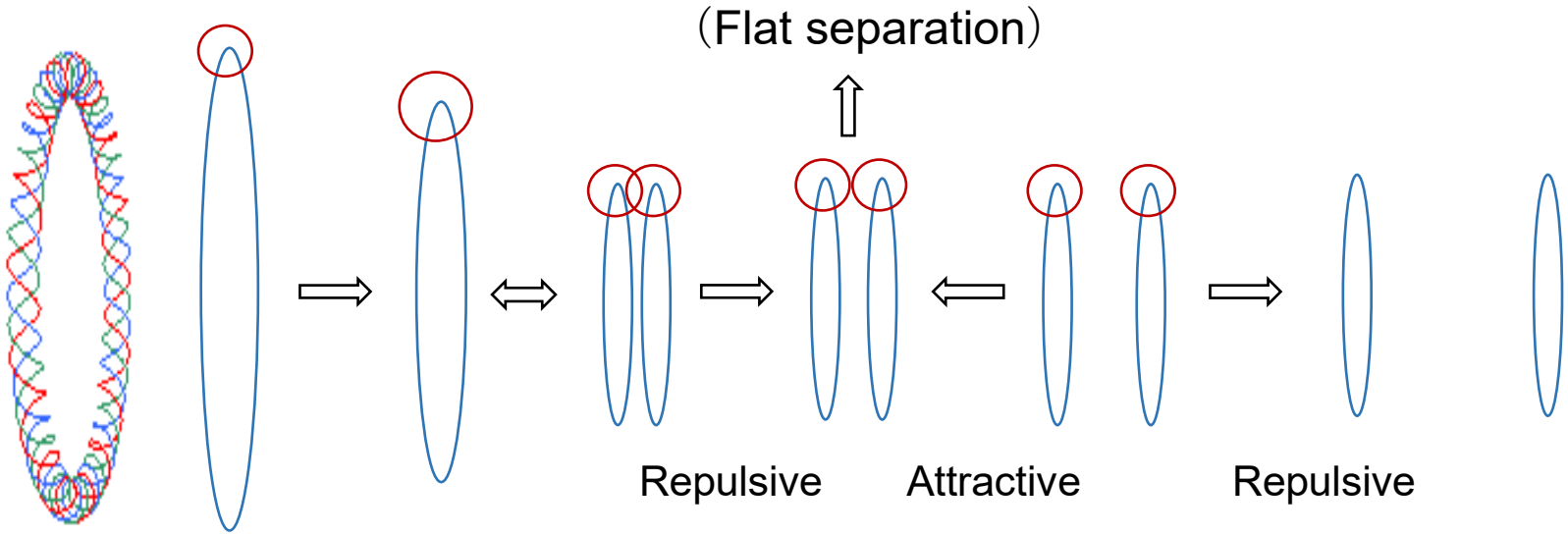
$$F_{ort}(S-S) = -F_{ort}\left(S-\overline{S}\right) = K_f \frac{{p_h}^2}{\pi {\mu_0}^2}\left(\frac{1}{x^2} - \frac{x}{(x^2+1)^{3/2}}\right)$$

$$f_{ort}(x) \equiv \pi\left(\frac{1}{x^2} - \frac{x}{(x^2+1)^{3/2}}\right)$$

$$F_{ort}(S-S) = Q_P f_{ort}(x)$$

Orthogonal interaction for small x:

Interaction of **Local circulations** becomes significant.



Orthogonal interaction of two space-space dimensional circulations. x_0 is the diameter of the **local circulation** (red circle). At $x = x_{min}$, two circulations fuse to one circulation (b)↔(c). The force is repulsive at $x_{min} < x < x_0$, attractive at $x_0 < x < x_1$ and repulsive at $x > x_1$.

< Energy expression of a Galactic seed >

1) An intrinsic energy M is circulating by $R\exp(i\Omega t)$.

$$E = MV^2 = MR^2\Omega^2$$

2) **Helical motion** of the next smaller-level intrinsic energy M_1, moving **linearly** at V and locally **circulating** at $V_c = \mu\omega$ by $\mu\exp(i\omega t)$.

$$E = M_1\left(V^2 + {V_c}^2\right) = M_1(R^2\Omega^2 + \mu^2\omega^2) = M_1{V_G}^2$$

Distribution (location) of E: $E\psi$

$$\psi = jVt + \mu\varphi = jR\Omega t + \mu\exp(i\omega t) = [R\Omega t \quad \mu\cos\omega t \quad \mu\sin\omega t]$$

Quantized as a continuous energy circulation.

$$\omega = n\Omega\,, \qquad (n = \text{integer})$$

From the balance of the centrifugal force and the intra-circulation force:

$$R \propto E$$

By a cyclic decomposition,

μ/R gets smaller, ω/Ω gets larger.

< Flat separation of a Galactic seed >

Assume, as an example, that separated two circulations have

$$\mu/R = 0.1\,, \qquad \omega/\Omega = 4\,.$$

$f_{flat}(x)$ for $S-S$ is applicable for $G-G$.

$$f_{flat}(x) = \frac{2x}{(x^2 + {x_0}^2)^{3/2}} - \frac{x-1}{((x-1)^2 + {x_0}^2)^{3/2}} - \frac{x+1}{((x+1)^2 + {x_0}^2)^{3/2}}$$

$K_f(V_G)$: force constant for intrinsic energies moving at V_G. (K_f: for $c = \mu_0\omega_0$)

$$x \equiv d/2R\,, \qquad x_0 \equiv 2\mu/2R = \mu/R\,, \qquad P_h = \frac{1}{2}M_1 V$$

Flat interaction force between two galactic seeds:

$$F_{flat}(G-G) = K_f(V_G)\frac{{P_h}^2}{\pi^2 R^2} f_{flat}(x)$$

$$Q_G \equiv K_f(V_G)\frac{{P_h}^2}{\pi^2 R^2}$$

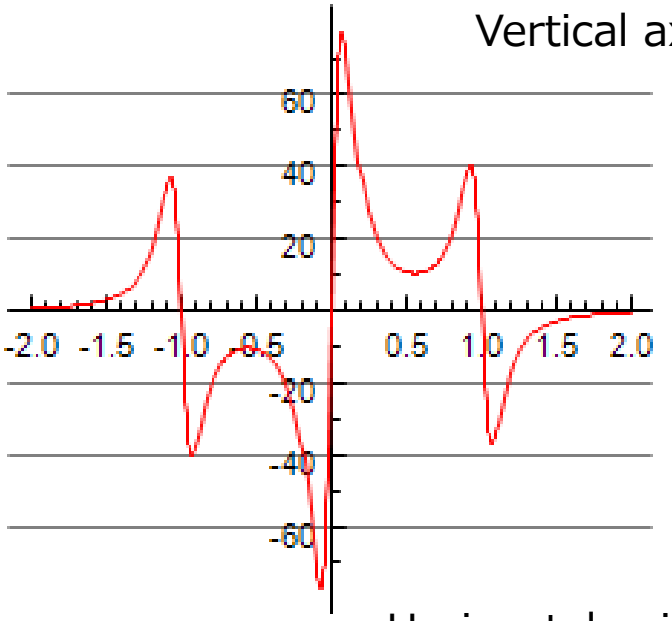
$$F_{flat}(G-G) = Q_G f_{flat}(x)$$

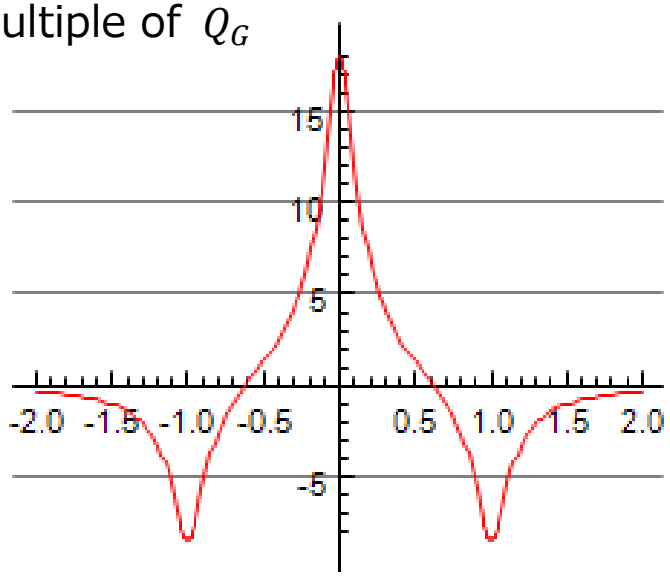
Potential energy: $U(x) = -\int F(x)dx + C$

$$\int x(x^2 + {x_0}^2)^{-3/2}dx = -\frac{1}{\sqrt{x^2 + {x_0}^2}}$$

$$U_{flat}(G-G) = Q_G\left(\frac{2}{\sqrt{x^2 + {x_0}^2}} - \frac{1}{\sqrt{(x-1)^2 + {x_0}^2}} - \frac{1}{\sqrt{(x+1)^2 + {x_0}^2}}\right)$$

Vertical axis: multiple of Q_G





Horizontal axis: relative distance to diameter $x = d/2R$

(a) Force (b) Potential energy

Force (a) and potential energy (b) of galactic seeds in a **flat interaction** versus the relative distance $x = d/2R$ in the circulation plane for $x_0 = 0.1$.

< Orthogonal separation of a Galactic seed >

Interaction of main circulations + Interaction of local circulations

1) Orthogonal interactions of main circulations

$$F_{ort}^{main} = Q_G f_{ort}(x)$$

2) Flat interaction of local circulations

$$P_h^{local} = \frac{1}{2} M_1 V_c = \frac{1}{2} M_1 V \frac{V_c}{V} = P_h \frac{\mu\omega}{R\Omega}$$

$$X \equiv d/2\mu$$

$$F_{flat}^{local}(X) = Q_{flat}^{local} \left(\frac{2X}{\left(X^2 + {X_0}^2\right)^{3/2}} - \frac{X-1}{\left((X-1)^2 + {X_0}^2\right)^{3/2}} - \frac{X+1}{\left((X+1)^2 + {X_0}^2\right)^{3/2}} \right)$$

$$Q_{flat}^{local} = K_f(V_G) \frac{\left(P_h^{local}\right)^2}{\pi^2 \mu^2} = K_f(V_G) \frac{{P_h}^2}{\pi^2 R^2} \left(\frac{\mu\omega}{R\Omega} \frac{R}{\mu} \right)^2$$

$$Q_{flat}^{local} = Q_G \left(\frac{\omega}{\Omega} \right)^2$$

$$f_{flat}^{local}(x) = \frac{2(x/x_0)}{\left((x/x_0)^2 + {X_0}^2\right)^{3/2}}$$

$$- \frac{(x/x_0) - 1}{\left(\left((x/x_0) - 1\right)^2 + {X_0}^2\right)^{3/2}} - \frac{(x/x_0) + 1}{\left(\left((x/x_0) + 1\right)^2 + {X_0}^2\right)^{3/2}}$$

$$F_{flat}^{local} = Q_G \left(\frac{\omega}{\Omega}\right)^2 f_{flat}^{local}(x)$$

3) Total force in an orthogonal separation

$$F_{ort}(G-G) = F_{ort}^{main} + F_{flat}^{local} = Q_G f_{ort}(x) + Q_G \left(\frac{\omega}{\Omega}\right)^2 f_{flat}^{local}(x)$$

Let $x_0 = 0.1$, $X_0 = 0.1$ and $\omega/\Omega = 4$.

$$F_{ort}(G-G) = Q_G \left(f_{ort}(x) + 16 f_{flat}^{local}(x)\right)$$

$$F_{ort}(G-G) = Q_G \pi \left(\frac{1}{x^2} - \frac{x}{(x^2+1)^{3/2}}\right)$$

$$+16 Q_G \left(\frac{20x}{((10x)^2 + 0.01)^{3/2}} - \frac{10x - 1}{((10x-1)^2 + 0.01)^{3/2}} - \frac{10x + 1}{((10x+1)^2 + 0.01)^{3/2}}\right)$$

4) Potential energy of galactic seeds in an orthogonal separation

$$U(x) = -\int F(x)dx + C\,, \qquad \int x(x^2+a)^{-3/2}dx = -\frac{1}{\sqrt{x^2+a}}$$

$$\int f_{ort}(x)dx = \int \pi\left(\frac{1}{x^2} - \frac{x}{(x^2+1)^{3/2}}\right)dx = \pi\left(\frac{1}{\sqrt{x^2+1}} - \frac{1}{x}\right)$$

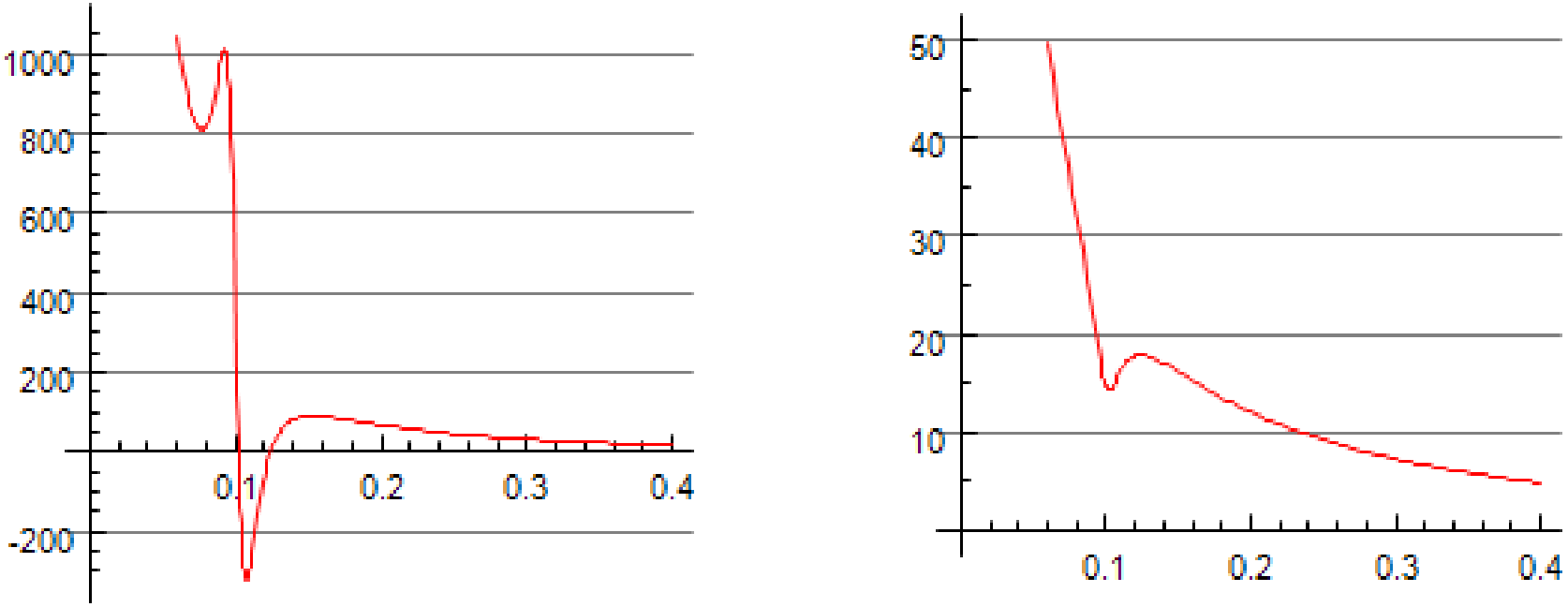
$$\int f_{flat}^{local}(x)dx = \int f_{flat}^{local}(x)dX\frac{dx}{dX} = 0.1\int f_{flat}^{local}(x)dX$$

$$(X = x/x_0 = 10x)$$

$$U_{ort}(G-G) = -Q_G\pi\left(\frac{1}{\sqrt{x^2+1}} - \frac{1}{x}\right)$$

$$+1.6Q_G\left(\frac{2}{\sqrt{(10x)^2+0.01}} - \frac{1}{\sqrt{(10x-1)^2+0.01}} - \frac{1}{\sqrt{(10x+1)^2+0.01}}\right)$$

Vertical axis: multiple of Q_G



Horizontal axis: relative distance to diameter $x = d/2R$

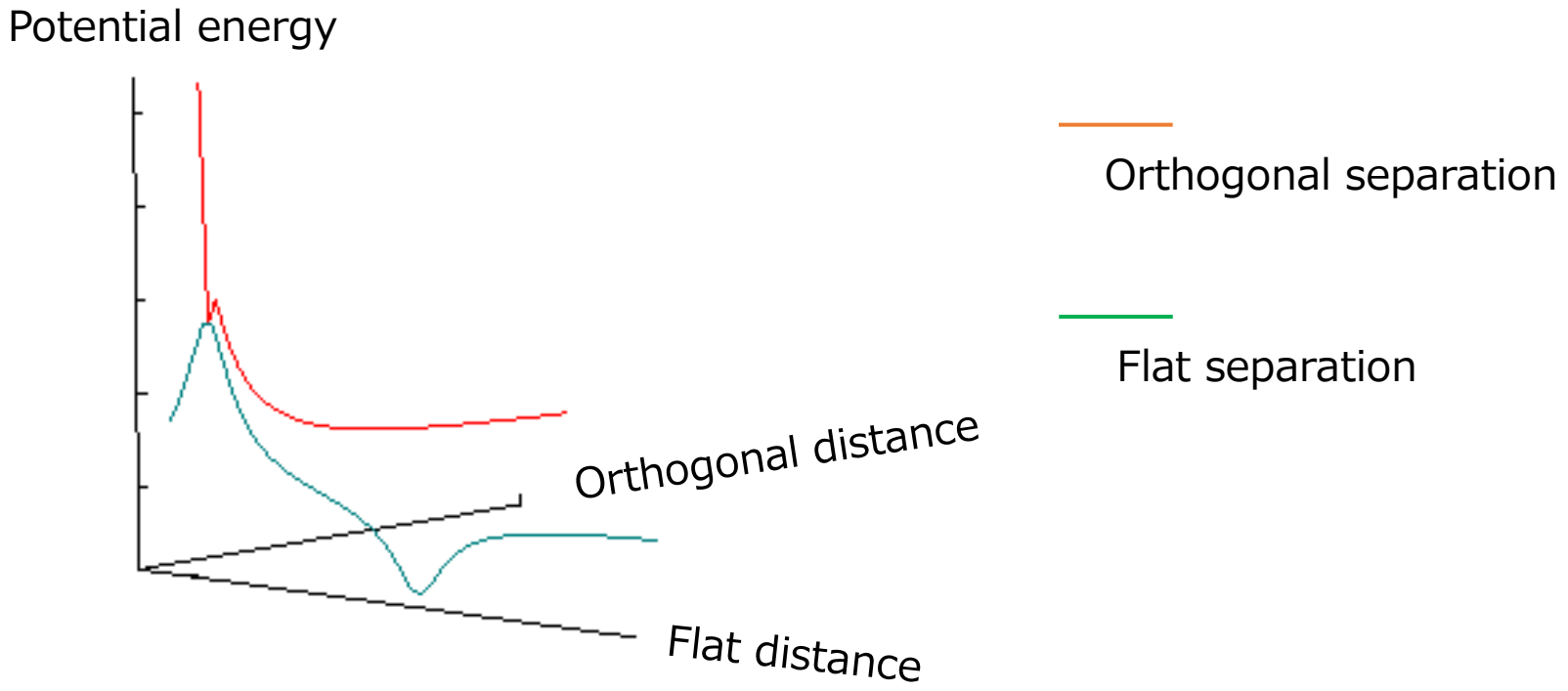
(a) Force (b) Potential energy

Force (a) and potential energy (b) of galactic seeds in an **orthogonal interaction** versus the relative distance $x = d/2R$ for $x_0 = 0.1$, $X_0 = 0.1$ and $\omega/\Omega = 4$. The graphs are for $0.06 \leq x \leq 0.4$ (the minimum x_{min} is unknown).

< Gamma-ray burst from a galactic seed separation >

Gamma-ray burst:

Difference in potential energy by a galactic seed separation is released.



Change of **potential energy** in a **galactic seed separation**

Release of potential energy in a galactic seed separation:

$$E = MV^2 = MV^2 + \Delta E_p - \Delta E_p = (M - \Delta M)V^2 + \Delta E$$

Change of potential energy is incorporated in that of the intrinsic energy.

ΔE is released by radiation or converts to the linear velocity v.

$$E = (M - \Delta M)V^2 + \Delta E = (M - \Delta M)(V^2 + v^2) + \Delta E_2$$

M : consists of various levels of energy circulations; M_1 , M_2 , $\cdots m$.

m : smallest level intrinsic energies moving at $c = \mu_0\omega_0$

Potential energies decrease simultaneously in all component circulations.

$\Longrightarrow$ Pulse radiation of energy

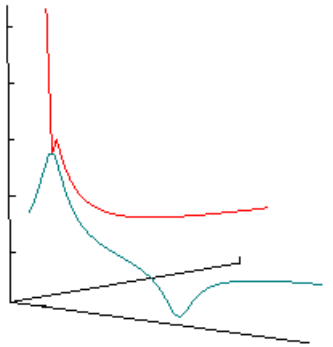
Space-space circulations:

- Flexible in the ratio of radiation and increase of velocity
- The radiation is the gravitational wave. Various levels of energy are possible, smallest one is the neutrino.

Hidden-space circulations: $p\_iS(x)$ is a prolonged iS with length x

- Quantized in the hidden dimension with the radius μ_0.
- ΔE is released only by light radiation. $p\_iS(x + \Delta x) \rightleftarrows p\_iS(x) + \Delta E(\gamma)$

Gamma-ray bursts



Type-1 GRB:

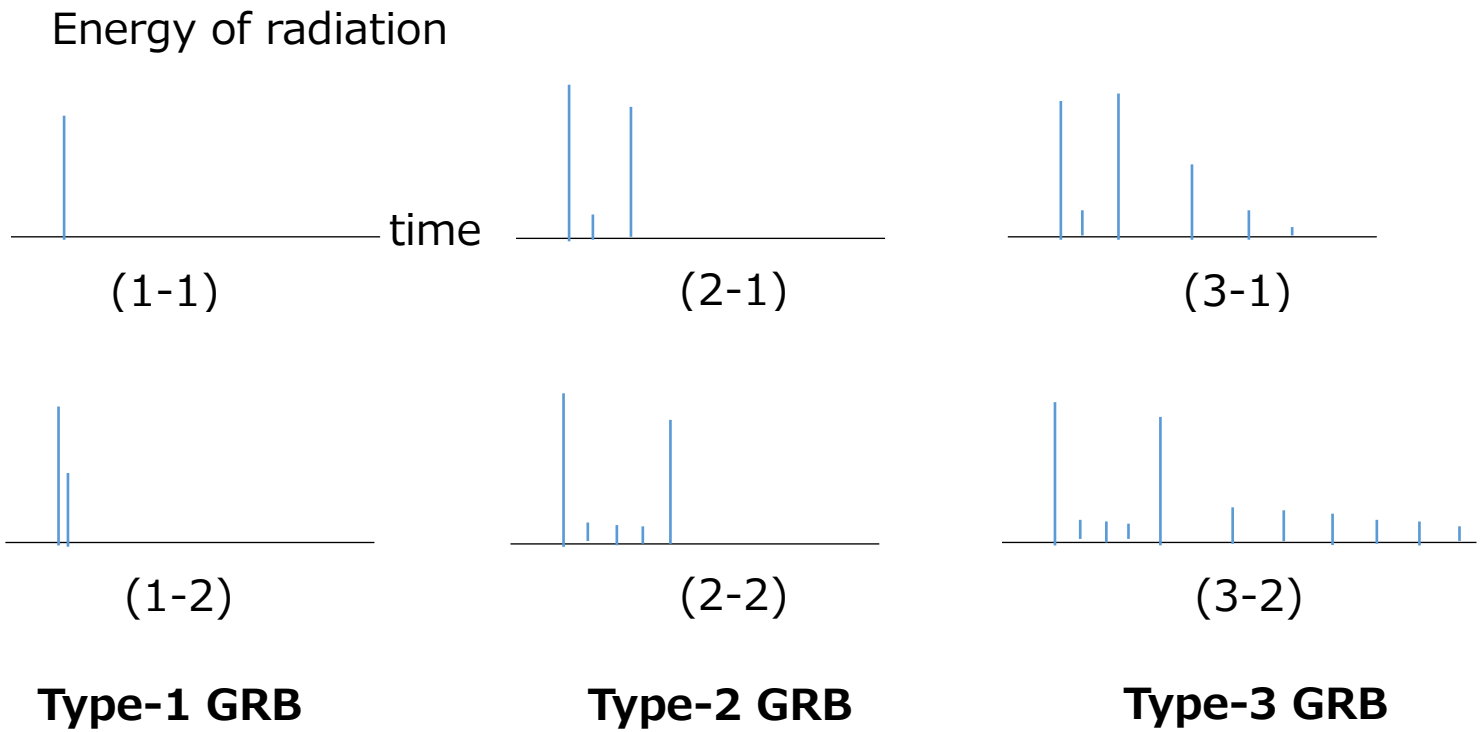
- Enough receding speed at the energy trough of orthogonal separation.
- Consists of only an orthogonal separation.
- Two seeds continue to recede.

Type-2 GRB:

- The distance vibrates around the trough and gets static.
- From the trough of orthogonal division, subsequent flat separation starts.
- If the speed at the trough of flat separation is high, the distance continues to increase or gets constant without a contraction.

Type-3 GRB:

- The receding speed is not enough in flat separation.
- The distance vibrates around the trough and releases radiations. Then, two seeds get static.
- Results in attached two galactic seeds, which will be a barred spiral galaxy



Examples of potential images for **time-course of gamma-ray radiations** in a gamma-ray burst. A pulse may be **split** to **plural spikes**. Individual gamma-ray pulses are often associated with **bremsstrahlung**, especially notable in a vibration around the energy trough (**afterglow**).

< Termination of galactic seed separations >

By a galactic seed separation, ω/Ω becomes a half.

Once the ratio gets $\omega/\Omega = 1$, a separation to two seeds is impossible.

Gamma-ray burst no longer occurs.

This is the reason why **no GRB** has been emitted since 130 MY ago.

After getting $\omega/\Omega = 1$, a simultaneous release of stellar seeds starts.

- Inclined separation of a local circulation to major one and tiny one occurs simultaneously on the whole circumference. Results in **a ring of stellar seeds**. (Partial cyclic decomposition)
- The ring can seamlessly expand as the space expands since it is not a continuous energy. It is kept as a ring by the intra-circulation force.
- Partial cyclic decompositions repeat and form a spiral galaxy.
- A circulating velocity of stellar seeds in a ring shall not alter by space expansion. Dark matter does not exist.

Published paper:

S. Nagao, The novel and common origin of gamma-ray bursts: a galactic seed separation with emitting radiations, *Rep. Adv. Phys. Sci.* **5** (1) (2021) 2150005.

https://doi.org/10.1142/S2424942421500055

Website:

Energy Circulation Theory (ECT) home

MiTiempo: Natures of the Time and the Universe