

# Establishing equivariant class $[\mathcal{O}]$ for hyperbolic groups

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## Abstract

This paper aims to create a class  $[\mathcal{O}]$  concerning the groups associated with Gromov hyperbolic groups over correspondence and equivalence through Fuchsian, Kleinian, and Schottky when subject to Laplace – Beltrami in the Teichmüller space where for the hyperbolic 3-manifold when the fundamental groups of Dehn extended to Gromov – any occurrence of Švarc-Milnor lemma satisfies the same class  $[\mathcal{O}]$  for quotient space and Jørgensen inequality. Thus the relation (and class) extended to Mostow – Prasad Rigidity Theorem in a finite degree isometry concerning the Quasi – Isomorphic structure of the commensurator in higher order generalizations suffice through  $CAT(k)$  space. The map of the established class  $[\mathcal{O}]$  is shown at the end of the paper.

**Keywords**– Teichmüller Space; Dehn; Švarc-Milnor; Jørgensen inequality; Laplace – Beltrami; Lickorish – Wallace; Haken Space.

## I Introduction

Any non-Euclidean geometry having a saddle or negative curvature where both the omega and Kretschmann scalar is less than 1 being defined for Riemann curvature tensor  $R_{mnop}$  there lies a vanishing Ricci  $R_{mn}$  through<sup>[1]</sup>,

$$K = R_{mnop}R^{mnop} \text{ for } deg[L]^{-4}$$

Every Gauss-Bolyai-Lobachevsky Space is a Riemann space provided it is a symmetric non-compact type where the Gaussian Curvature  $G$  being negative gives the inverse root where there exists a limit in the Geodesic curvature for 2-such cases as identified<sup>[2]</sup>,

$$\frac{1}{\sqrt{-G}} = \begin{cases} 1, & \text{Horocycle} \\ [0,1], & \text{Hypercycle} \end{cases}$$

Riemann and Hyperbolic space are equivalent over actions on PGL groups for any isomorphism over 3-manifold as the Dehn surgery segregates the Flat (Euclidean) from hyperbolic provided any 3-manifold can take on different geometries for the same structures where the conformal boundary associated with the Riemann sphere can be distinguished by group<sup>[3]</sup>,

$$PGL(2, \mathbb{C})$$

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## II Gauss-Bolyai-Lobachevsky Theorem with Dehn Surgery

Being associated with the homology classes and established over simplicial norm there exists the Dehn Link and Dehn Twists satisfying the properties<sup>[4]</sup>,

- [1] *Lickorish - Wallace Theorem* – Where Dehn Twist  $D$  can be defined as an automorphism for roundabout channel  $C$  such that the mapping factor  $\varphi$  gives,

$$\varphi: C \rightarrow C \text{ over time } T \text{ giving } D \cong Ce^{i2\pi T} \exists T \in [0,1]$$

- [2] *Manifold Type* – Closed and orientable.

## III Fuchsian Group

By taking the Gauss-Bolyai-Lobachevsky over the associated and irreducible prescriptions of Dehn Twist the  $PGL(2, \mathbf{C})$  preserves the isometry for any Hyperbolic 3-manifold – a category where the necessary functors of orientations suffice the Möbius Transform group we get a Kleinian group representing the Riemann sphere over conformal transformations in  $PSL(2, \mathbf{C})$ . Thus by considering 2 factors a realization can be made for connections of Fuschain to Kleinian groups<sup>[5]</sup>,

- [1] Categorizing Kleinian as the discrete subgroup  $\omega$  and the hyperbolic 3-manifold as  $M_H^3$  then two cases can be established over the equation,

- a. Co-compact being finitely co-volume
- b. Co-volume being finitely generated
  - i. *Over* –  $M_H^3/\omega$

- [2] For the real domain  $R$  of  $PSL(2, \mathbf{C})$  then over any finite generations being an isometry group taking on the upper half of the unit disc throughout any conformal transformations – it can be shown that<sup>[6]</sup>,

- a.  $M_H^3$  is discontinuous over  $PSL(2, \mathbf{R})$  when Kleinian takeover the Fuchsian for the discrete subgroup  $\omega$ .
- b. For any polynomial  $P$  there exists a non-repetitive root for the equation

$$x^3 + ax + b$$

$\exists$  there exists a  $deg_3$  Potential of  $P$  in  $x$  for every  $y^2$  establishing the above equation

- This again gives another subgroup  $\omega^0$  satisfying the moduli space of  $y^2$  via  $PSL(2, \mathbf{Z})$
- Fuchsain norms for non-abelian  $\omega$ .
- $PSL(2, \mathbf{C})$  is then satisfied for the hyperbolic 3-fold over functors  $M_H^3$  of Möbius group where a 2-sphere  ${}_B^3S^2$  is taken at infinity being associated

with the conformal homeomorphism where there exists an associated hyperbolic isometry on 3-ball  $B^3$ . Thus the discontinuity as mentioned in [a] of point [2] gives an extension to 2 categories<sup>[7]</sup>,

- A. Schottky group over any Hausdorff measure  $h < 2$  for the discrete subgroup  $\omega$  for  $2g$  weight for a total convergence over the bundle norm  $b \geq 1$  over linear fractional transformations  $\partial \equiv \frac{\partial_1}{\partial_2}$ ,

$$\sum_{\partial \in \omega} \partial_2^{-2g} h \partial \exists \text{ as mentioned earlier } H \text{ is Hausdroff } < 2 \cong \text{Poincaré series } b \geq 1$$

B. Denoting area of discontinuity  $D^0$  we again get 2 relations,

1. *Orbifold Riemann* – for the discrete subgroup  $\omega$  there is  $D^0(\omega)/\omega$
2. *Fuchsian*  $\equiv$  *Schottky* – For area inequality  $D^0/\omega$ .

## IV Teichmüller Space

Any Teichmüller space  $T(M)$  can be defined over a Riemann manifold  $M$  endowed with a hyperbolic structure where there exists identity homeomorphism. For any universal covering making an identification for genus  $g \geq 2$  - The compact structure or the surface that the topology establishes prescribed 5 interrelated parameters<sup>[8]</sup>,

- [1] Non-compact space
- [2] Teichmüller space  $T(M)$
- [3] Fuchsian group
- [4] Isotopy norm over Riemann  $M$  for metric  $g_M$  suffice smoothness  $s$ ,

$$s \sum_{i=1}^n dx_i^2$$

[5] Uniformization theorem for Hyperbolic 3-folds taking Thurston's 8-geometries taking over<sup>[9]</sup>,

- Point [4] noting  $s \sum_{i=1}^n dx_i^2$  as metric  $d\ell^2$  giving,
  1. Hodge star  $\star$  for isothermal coordinates equipped with above metric  $d\ell^2$  such that for smoothness  $s$  there exists *Jacobian*  $\neq 0$ ,
  2.  $s$  is equipped with the differential  $\partial\alpha^2 + \partial\beta^2$  (Let  $\alpha, \beta$  be the coordinates where  $\star$  generates 3 peculiar forms,
    - $\star \partial \star \partial$
    - $\star \partial \alpha = \partial \beta$
    - $\star \partial \beta = \partial \alpha$
- *Laplace - Beltrami* – For the exterior derivative (being non-trivially hidden in sub-points 1 and 2 under [5]) we would be

getting a scalar potential  $\phi$  such that this can be differentiated for the Riemann metric  $g_M$  over<sup>[10]</sup>,

$$\partial_m |g_M|^{-1/2} (\partial_m \phi g_M^{mn} |g_M|)$$

Giving area inequality  $D^0/\omega$  for discrete subgroup  $\omega$  with a discontinuity  $D^0 - Schottky \cong Fuchsian$  provided Poincaré series stands at  $b \geq 1$ . While all this occupying genus  $g$  Teichmüller is identified with the Fuchsian over 3 norms<sup>[11]</sup>,

1. Genus  $g \geq 2$
2. Ball  $B$  having  $deg_{6g-6}$
3. For scalar potential  $\phi$  with Riemann  $\partial_m |g_M|^{-1/2} (\partial_m \phi g_M^{mn} |g_M|)$  there exists<sup>[12]</sup>,
  - a.  $T(M) \xrightarrow{\text{bijection}} (M, \phi)$
  - b. Equivalence class  $[\mathcal{O}]$  for the isotopy, diffeomorphism, and holomorphism such that for closed interval  $[0,1]$  Teichmüller gives<sup>[13]</sup>,
    1.  $T(M) \Rightarrow (g_M, M)$
    2. Diffeomorphism to  $\phi$  for contractable  $\mathbb{R}^2 \forall 6g - 6$  making an equivalence as,

$$[\mathcal{O}] \equiv T(M) \cong \mathbb{R}^2 \forall 6g - 6 \exists Fuchsian \equiv Schottky \equiv Klenia \Rightarrow \text{Lie Group } \text{PSL}_2(\mathbb{R})$$

## V Gromov Hyperbolic Groups

No 3-dimensional manifold can occupy a single class of geometry. Where either there exists a certain curvature on the outside while a certain curvature is inside. In some cases – the structure can be equipped with the surface geometry taking different curvatures on different parts to say the frequency concerned with that manifold. There have been groups equipped with structures for the homotopy invariant spaces but the segregation can be possible by the Dehn surgery for making a distinct classification from Euclidean to Hyperbolic geometries. Any isomorphisms can be satisfied by this homotopy invariant spaces  $M_X$  that are Riemann with a negative curvature. Thus taking  $X$  as the topological space for the negative Riemann  $M$  - one can deduce the fundamental groups for a completely connected path along the surface being parameterized by  $P$  along  $X$ <sup>[14]</sup>,

$$\rho_1(X_P)$$

If we take another topological space  $Y$  for hyperbolic manifold  $M_Y$  then we can deduce 3 relations making a symmetric equivalence for class $[\mathcal{O}]$ <sup>[15]</sup>,

1. For any hyperbolic 3-manifold  $\rho_1(X_P)$  satisfies a quasi-isometric form such that for any definite  $deg_{\text{finite}}$  Lie Group  $\mathcal{L}$  one can find the Riemann metric  $g_M$  where there exists closed-connectedness between the topological manifold  $M_X$  or  $M_Y$  satisfying quotients via<sup>[16]</sup>,

$$\check{S}varc - Milnor lemma = \begin{cases} X/\mathcal{L} \\ Y/\mathcal{L} \end{cases} \quad \forall \rho_1(X_P) \simeq \rho_1(Y_P) \exists \wedge: M_X \rightarrow M_Y$$

2. The quotient topology norm with *Švarc – Milnor lemma* is indeed equivalent to the same fundamental group denoted as  $G_{\mathcal{L}}$  suffice<sup>[17]</sup>,

$$\begin{cases} \rho_1(X_P) \rightarrow \rho_1(X_P/G_{\mathcal{L}}) \\ \rho_1(Y_P) \rightarrow \rho_1(Y_P/G_{\mathcal{L}}) \end{cases} \cong G_{\mathcal{L}}^{\text{Note 1}}$$

3. For establishing equivariant hyperbolic groups for class  $[O]$  – The hyperbolic 3-manifold  $M_H^3$  suffices an inequality relation over the same class correspondence –  $[O]$  –<sup>[18]</sup>

$$[O] \equiv \begin{cases} \text{Quotient Topological Space } M_H^3/G_{\mathcal{L}} \\ \text{Jørgensen inequality} \end{cases} \cong \text{Kleinian Groups}$$

If we take any complex plane  $\mathbb{C}$  and suffice that any element existing on that complex plane gives the trace  $\mu^1$  and  $\mu^1$  of a  $2 \times 2$  matrix then any parabolic function gives the cusp of a Riemann 3-fold that iff generates through the Kleinian Groups then – This suffice a correlation for any suitable parameters belonging to those traces  $\mu^1$  and  $\mu^1$  norms,

$$\cong \text{Fuchsian Group for } \mathbb{U}^{\frac{1}{2}}/G_{\mathcal{L}} \exists \gamma := \mathbb{U}^{\frac{1}{2}}/G_{\mathcal{L}}^{\text{Note 2}}$$

This again suffices the  $[O]$  – class in a more concrete structure.

## V.I Mostow – Prasad Rigidity Theorem

If we take the same fundamental group of Dehn which Gromov extended – for the hyperbolic 3-fold then we will again find ourselves embedded in the Teichmüller space for every  $deg_{\text{finite}}$  closed manifolds one would surprisingly find the  $[O]$  – class equivariant as stated in [Page 5] for manifold  $M$  suffice Teichmüller  $T(M)$  in contractable  $\mathbb{R}^2$  for all that norm  $6g - 6$  taking the Lie Group  $\text{PSL}_2(\mathbb{R})$ <sup>[19]</sup>.

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Note 1 – Higher order generalizations for the fundamental group can be achieved by making  $\rho_n(X_P)$  and  $\rho_n(Y_P)$  for closed-connectedness between the topological manifold  $M_X$  or  $M_Y \exists \wedge: M_X \rightarrow M_Y$  where in the case of complex plane  $\mathbb{Z}$  – There are higher-order homotopy groups of  $n$  – spheres  $S^n$  in the  $\rho_n$  order making as  $\rho_n(S^n)$

Note 2 –  $\mathbb{U}^{\frac{1}{2}}$  denotes the upper half-plane where for any projections parameterized by  $\gamma$  there exists a difference in the relational subset for Group –  $G_{\mathcal{L}}$  from its mean  $\langle G_{\mathcal{L}} \rangle$

For assessment of clarifications when the connected path  $P$  along topological space  $X$  for the concerned manifold  $M_X$  – as we have seen in Švarc – Milnor lemma where the established equation of path connectivity  $\rho_i(X_P)$  takes<sup>[20]</sup>,

$$\sum_{i=1}^n \rho_i \bigvee_{p \in p^n} X_P$$

The map  $\wedge: M_X \rightarrow M_Y$  goes prominent in the same  $deg_{finite}$  isometry where the fundamental group  $\rho_i \exists i$  takes  $[1, n]$  – the same map can be re-written through this group structure,

$$\wedge: \sum_{i=1}^n \rho_i(M_X) \rightarrow \sum_{i=1}^n \rho_i(M_Y)$$

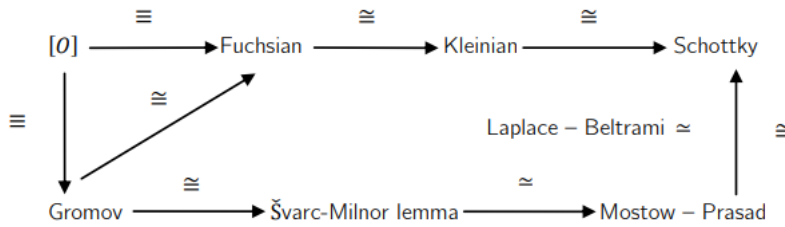
The same class can be satisfied for  $n$  – sphere via any higher degree generalizations – where  $M_H^3 \rightarrow M_H^n$  via,

$$\rho_n(S^n)$$

The large-scale structures are highlighted for any established  $deg_{finite}$  connectivity where a peculiar functor **Comm** takes over the generators of the group  $G_L$  where there exists the path-connectivity for some arbitrary commensurator  $\Pi$  over any intersections of sub-group  $G_L^1$  and  $G_L^2$  such that the **Comm** over group  $G_L$  establishes<sup>[21]</sup>,

**Comm**( $\Pi$ ) justifies  $G_L^1, G_L^2 \in G_L$  iff  $\Pi \equiv$  Quasi – Isomorphic

Hence a  $[O]$  – class equivariant relation,



**Figure:** This image depicts the equivariant class  $[O]$  to establish the objective of this paper.



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