Talk : BMS - invariant field theories (1)

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(1) BMS$_3$

$$S_E = \int du\, dz \left(\frac{1}{2} \dot{\phi}^2 - V(\phi) \right)$$ Electric

Carroll invariant

BMS$_3$

$$L(z) = - b(z)\, \partial_z + b' [u \partial_u + h] \qquad M = a(z)\, \partial_u$$

$$\delta\phi = b \phi' + b' (u \dot{\phi} + h \phi) + a \dot{\phi}$$

Kinetic terms : $h = 0$

Potential : never invariant

Add $\delta\phi = L\phi + c(z)$

kinetic term invariant

$$\delta V = \frac{\partial V}{\partial \phi} \left(b\phi' + b' u \dot{\phi} + a\dot{\phi} + c \right)$$

$$= - b' V - b' V + c \frac{\partial V}{\partial \phi}$$

solution : $V(\phi) = \alpha e^{\beta\phi}$

$c(z) = \frac{2b'}{\beta}$

Liouville - potential BMS$_3$

Barnich
Gomberoff
Gonzales '12
1210.0731

$$[L_n, L_m] = (n-m) L_{n+m} + \frac{c_L}{12} n(n^2-1)\delta_{m+n,0}$$

$$[L_n, M_m] = (n-m) M_{m+n} + \frac{c_M}{12} n(n^2-1)\delta_{m+n,0}$$

$$[M_m, M_n] = 0$$

Electric - Carroll - Liouville

$$\boxed{c_L = 0 = c_R}$$

Magnetic ?

$$S_M = \int du\, dz\, (\chi \dot\phi + \mathcal{L}(\phi)) \qquad \underline{\text{Carroll}}$$

Specify $\quad \mathcal{L}(\phi) = -\frac{1}{2}\phi'^2 + V(\phi)$

For $V = 0$

$$\delta\phi = b\phi' \qquad \delta\chi = (b\chi)' + (f\phi')'$$

$f = a + ub'$ $\qquad$ $\underline{BMS_3}$! $\qquad c_L = c_M = 0$

$V \neq 0$? Only Liouville again $\qquad \frac{c_M}{12} = \frac{8\pi}{\beta^2}$

$$V = -\frac{\nu}{\beta^2} e^{\beta\phi} \qquad \boxed{C_L = 0 \qquad c_M = \frac{3}{G}} \quad \text{BGG}$$

$$\delta\phi = b\phi' + \frac{2}{\beta} b' \qquad \delta\chi = (b\chi)' + (f\phi')' + f\frac{\partial V}{\partial\phi} + \frac{2}{\beta} f''$$

$$\beta = \sqrt{32\pi G}$$

Other magnetic theories

$$S = \int \chi \dot{\phi} - \frac{1}{2} \phi'^2 + V$$

Classically

$$\boxed{\begin{aligned} \delta\phi &= b\phi' \\ \delta\chi &= (b\chi)' + (f\phi')' + u b' \frac{\partial V}{\partial \phi} \end{aligned}}$$

- Again, no central charges
- Generalizable to d-dimensions

② $\underline{BMS_4}$

$$L_n = -\left(z^{n+1}\partial_z + (n+1)z^n\left[\frac{u}{2}\partial_u + h\right]\right)$$

$$\bar{L}_n = -\left(\bar{z}^{n+1}\partial_{\bar{z}} + (n+1)\bar{z}^n\left[\frac{u}{2}\partial_u + \bar{h}\right]\right)$$

$$M_{p,q} = z^p \bar{z}^q \partial_u$$

Electric $\quad S = \int du\, dz\, d\bar{z} \left(\frac{1}{2}\dot{\phi}^2 - V\right)$

scalars $\quad h = \bar{h} = \frac{1}{4} \quad // \quad BMS_3 \quad h = 0$

$$\Delta = h + \bar{h} = 1/2 \qquad V(\phi) = g\phi^6$$

Also

$$L = \frac{1}{2} g_{ij} \dot{\phi}^i \dot{\phi}^j - V(\phi)$$

$$\phi^i \partial_i V = 6V$$

O(N) model $\quad V = g\,|\phi^i \phi^i|^3$

$$J \equiv \phi^i \phi^i \qquad \Delta = 1$$

massless bulk field. $\quad \boxed{\Delta = \frac{d-1}{2}}$

holographic dictionary

$\Delta = 1 \quad d = 3$

spatial.

First order theories

$$L = \frac{1}{2} a_{ij} \phi^i \dot{\phi}^j - \frac{1}{3} d_{ijk} \phi^i \phi^j \phi^k$$

antisymm.

BMS_4 : $\quad h = \bar{h} = 1/2 \qquad \Delta = 1$ scaling weight.

More promising correlation functions as S-matrix

// CS-theory ? $\Rightarrow \ldots \Rightarrow$ ABJM which

Upshot

$\underline{BMS_3}$ electric-Carroll Liouville

magnetic Liouville $\leftrightarrow$ Einstein gravity

Conjecture

$\underline{BMS_4}$ Carroll limit ABJM

$\updownarrow$

4D Einstein gravity!