Dyons near the transition temperature in $SU(3)$ lattice gluodynamics

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Old:

- There are dyons
- Dyons were seen in $SU(2)$,$SU(3)$,QCD
- By methods of cooling, smearing, filtering with the help of low-lying fermion modes
- Properties were investigated

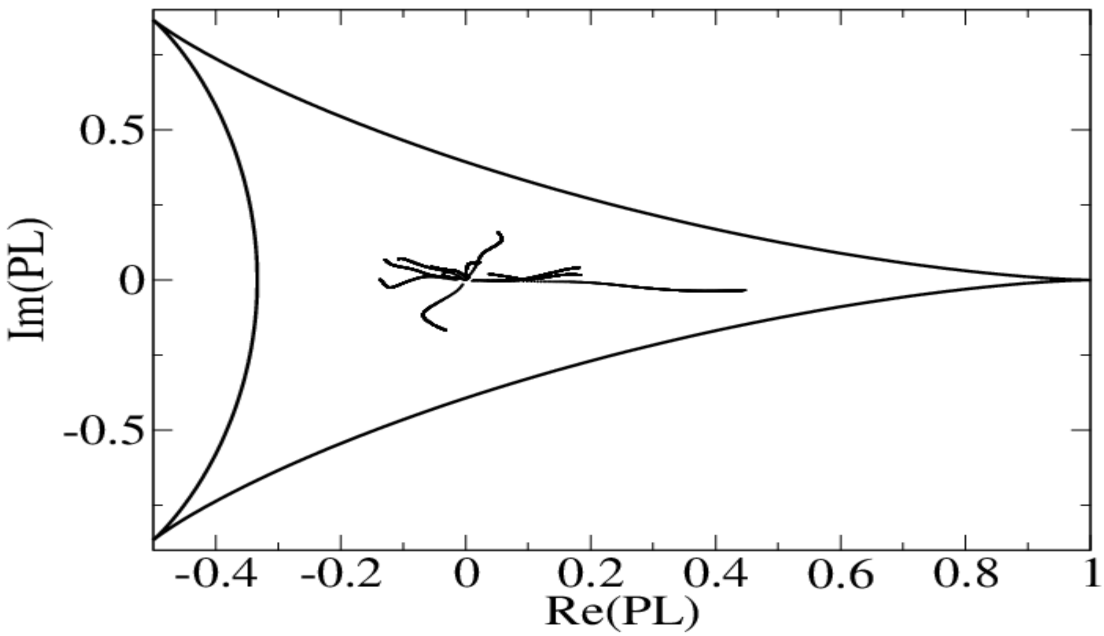
New:

- Gradient flow
- Flow with respect to overimproved action
- monitoring of IPR of $|q(x)|$

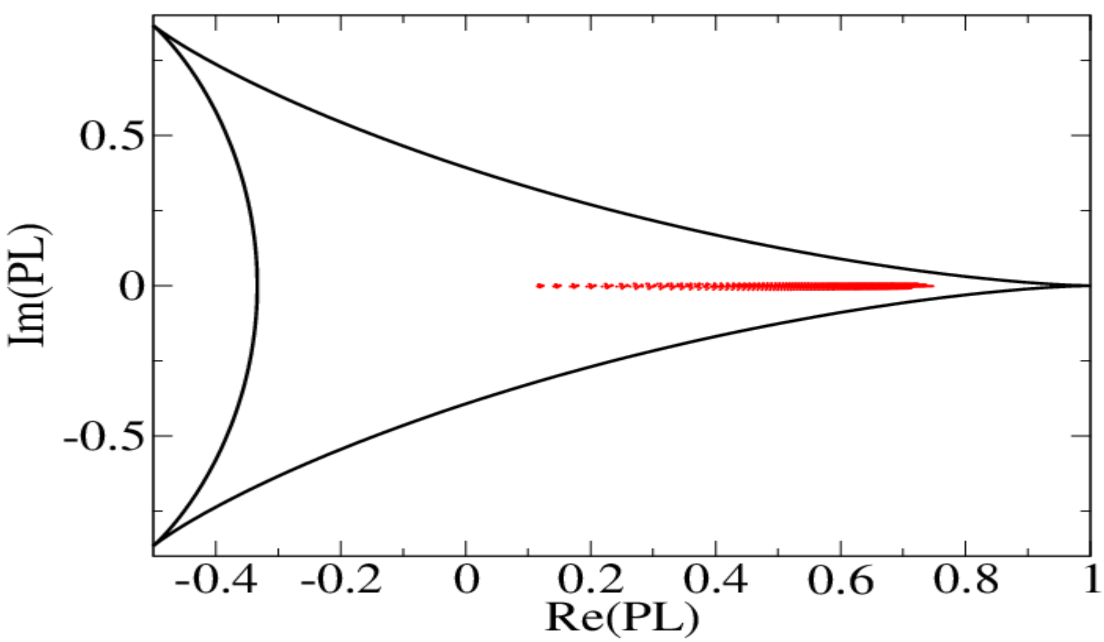
$$\mathrm{IPR} = V_4 \frac{\sum_x |q(x)|^2}{(\sum_x |q(x)|)^2} \qquad 1 < \ \mathrm{IPR} < \ V_4$$

- IPR$=\pi/2$ in thermal configurations with Gauss distribution
- IPR grows with the removal of perturbative fluctuations when topological objects appear above the perturbative background

- IPR grows when the number of top. objects decreases due to annihilation of dyons and antidyons
- IPR goes down when caloron dissociates to constituent dyons
- IPR grows when dyons holonomy goes to the trivial value



Over-improved flow histories of the volume-averaged Polyakov loop for 12 configurations below T_c



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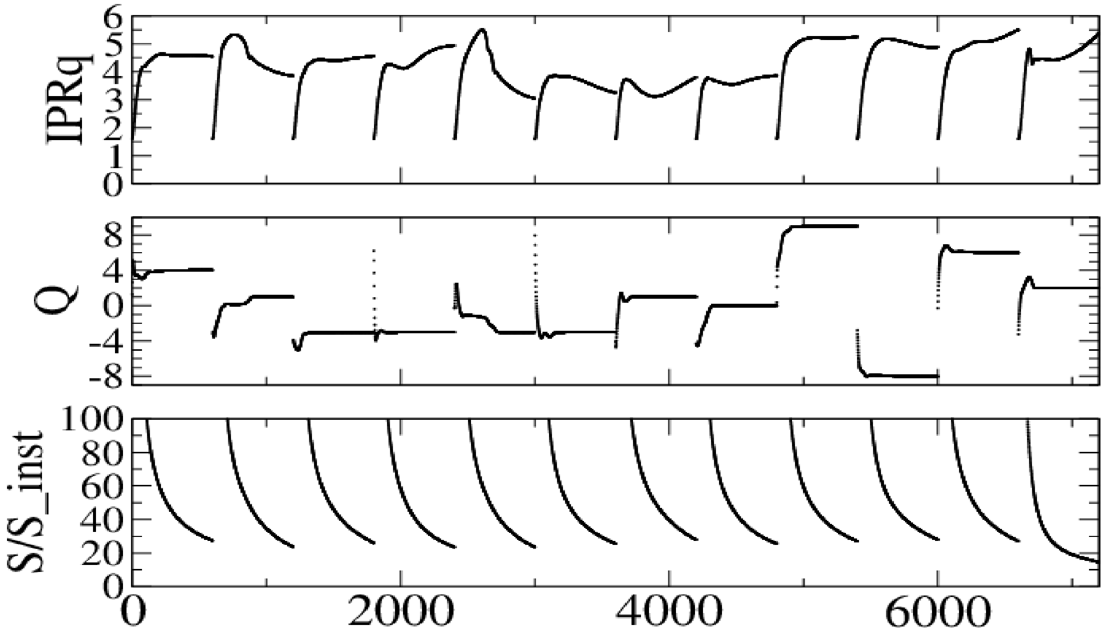
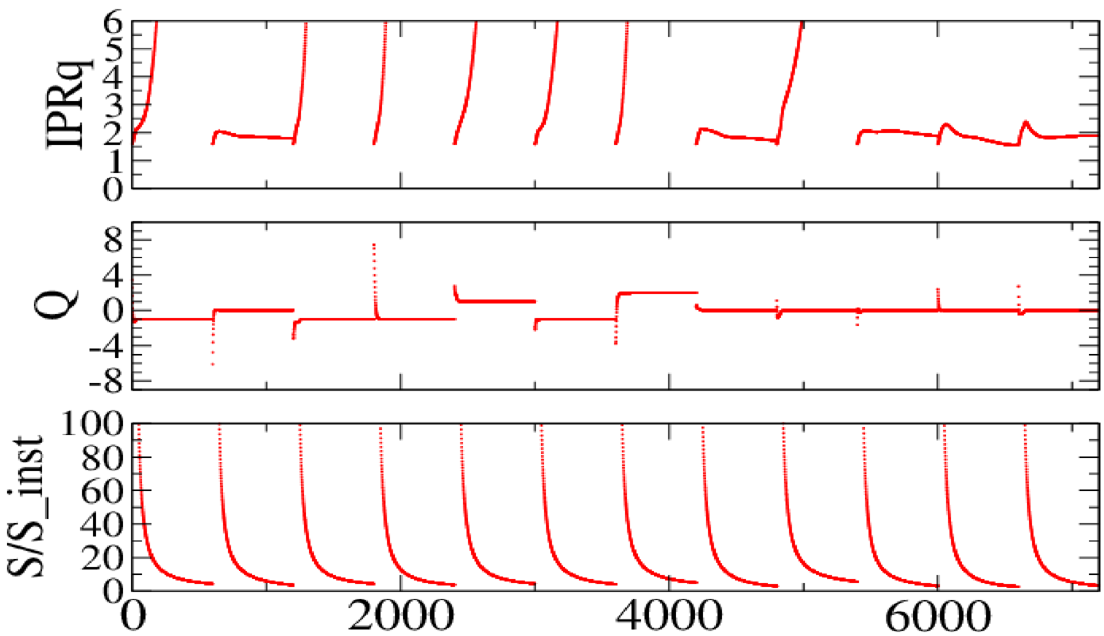
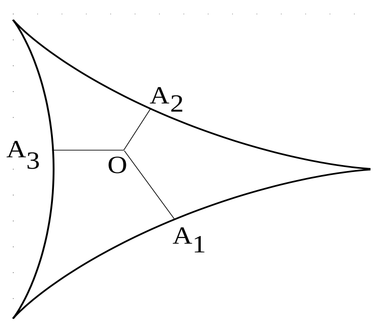


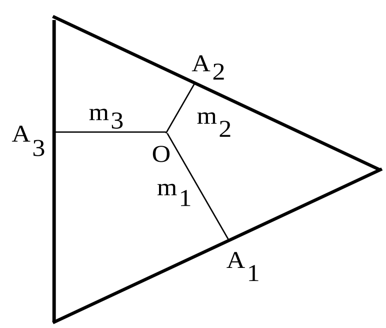
Over-improved flow histories for 12 configurations below T_c



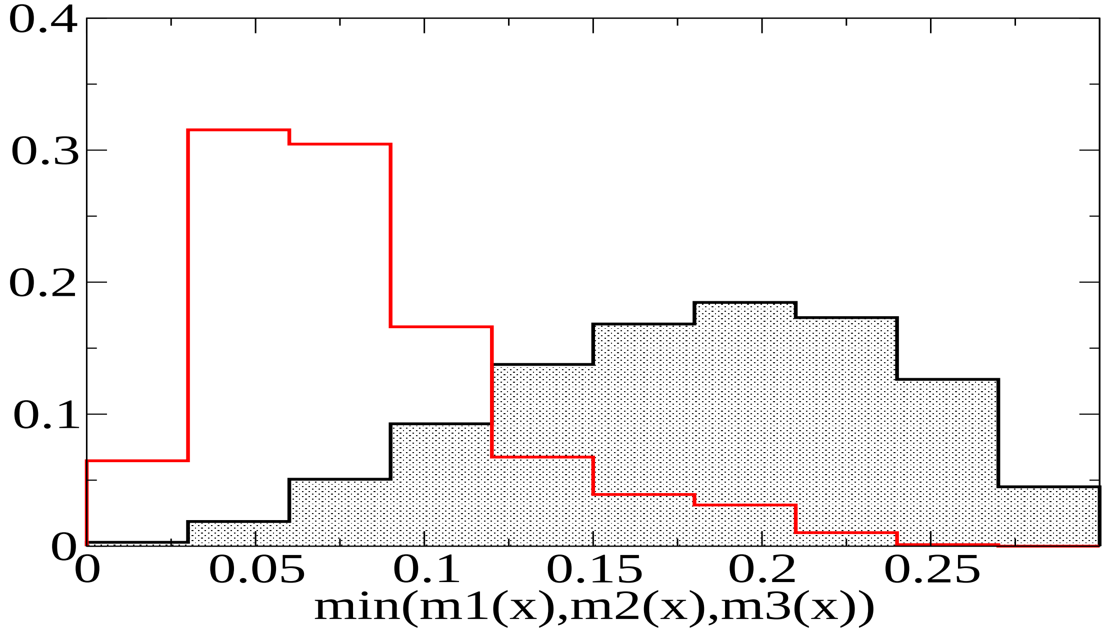
Over-improved flow histories for 12 configurations above T_c

- Correlation of Abelian monopoles with Polyakov line
- MAG $\rightarrow$ Abelian projection $\rightarrow$ timelike monopole links dual to 3-d monopole carring cubes
- PL $\rightarrow \min(m_1, m_2, m_3)$

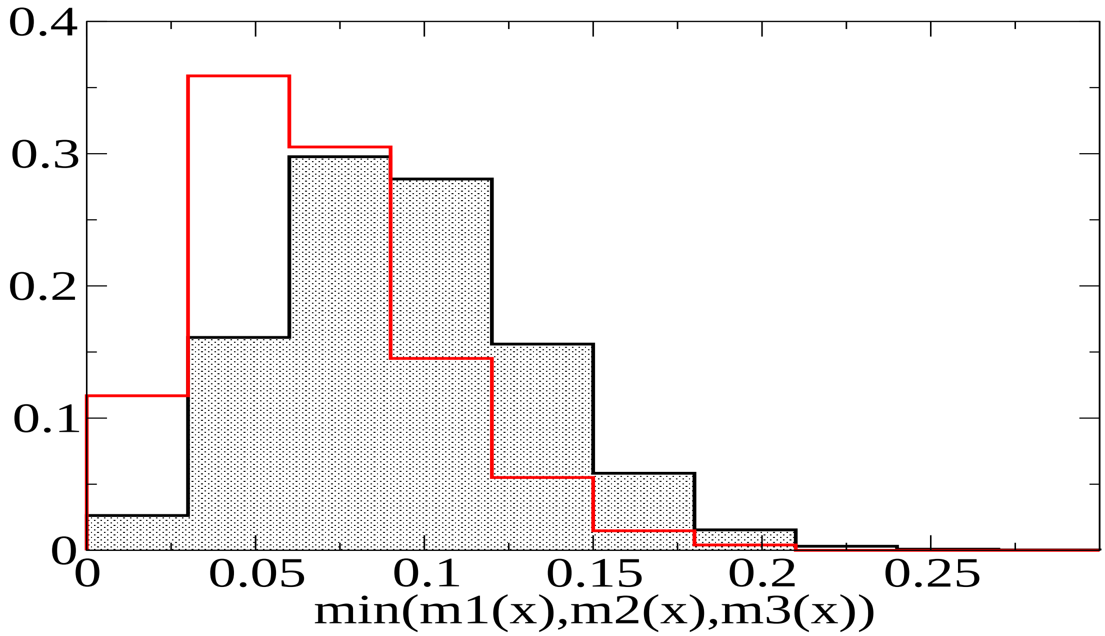




$$1/3\mathrm{Tr}(SU(3)) = f(m_1, m_2, m_3)$$



The distributions of $\min(\mathrm{m}_1(\mathrm{x}), \mathrm{m}_2(\mathrm{x}), \mathrm{m}_3(\mathrm{x}))$ over all lattice sites (shaded histogram) and for all cubes where thermal monopoles are located (open red histogram) below T_c

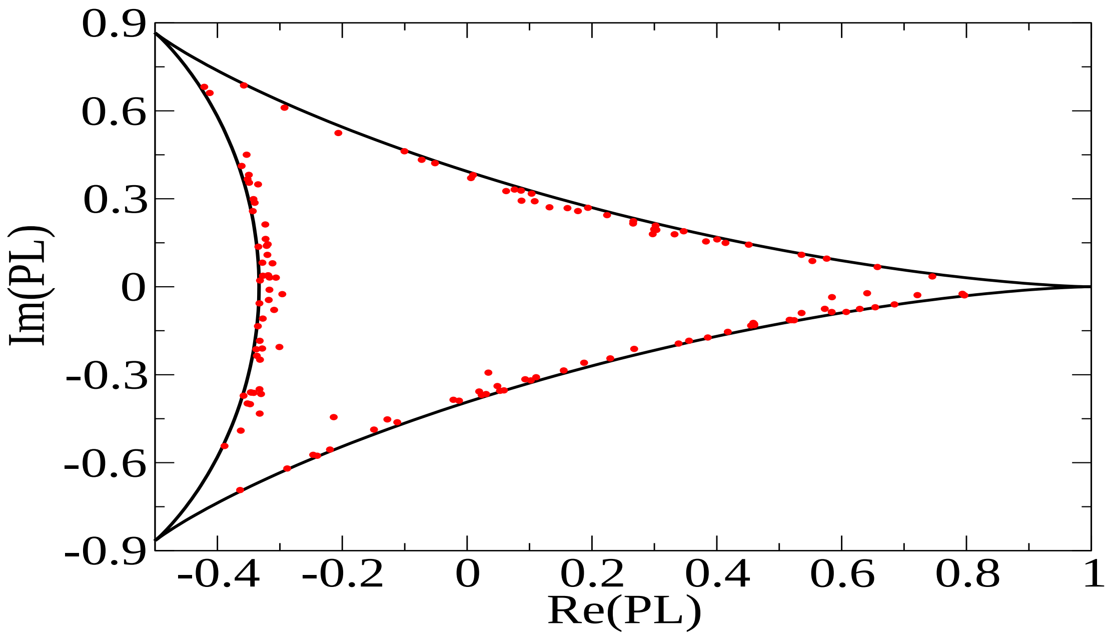


The same above T_c

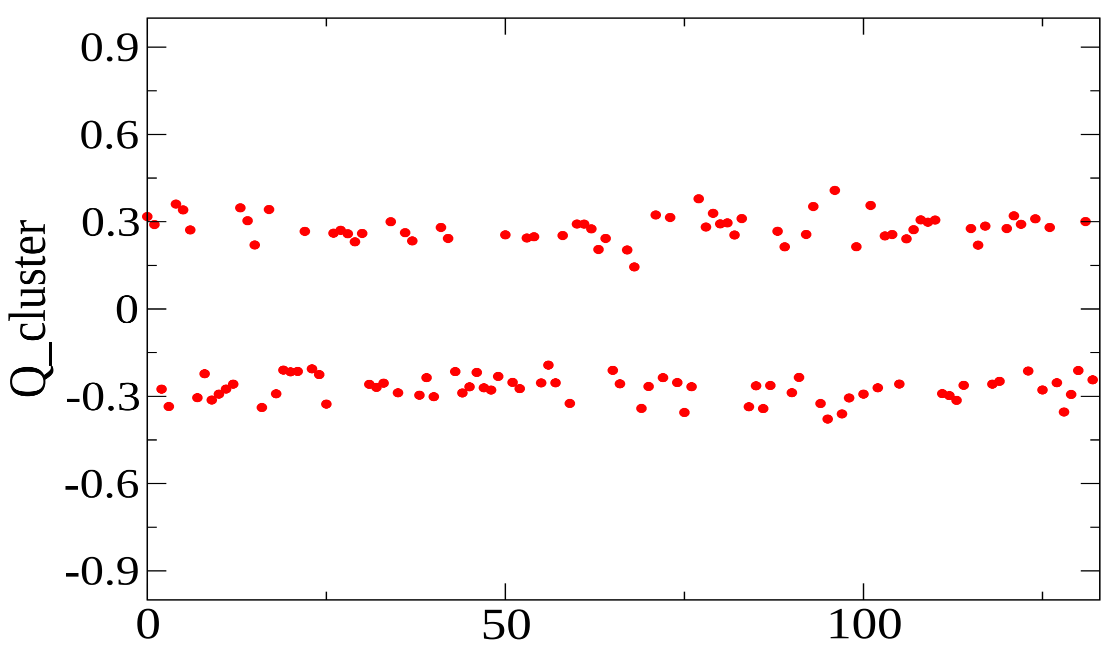
- Cluster analysis

phase	V_{cl}	V_{clmon}	N_{cl}	N_{clmon}
$T = 0.79\ T_c < T_c$	2.6(1)%	2.4(1)%	15.4(2)	10.4(2)
$T = 1.27\ T_c > T_c$	2.7(3)%	1.0(1)%	29(2)	3.0(2)
$T = 1.5\ T_c > T_c$	4.7(3)%	1.2(1)%	45(2)	3.0(2)

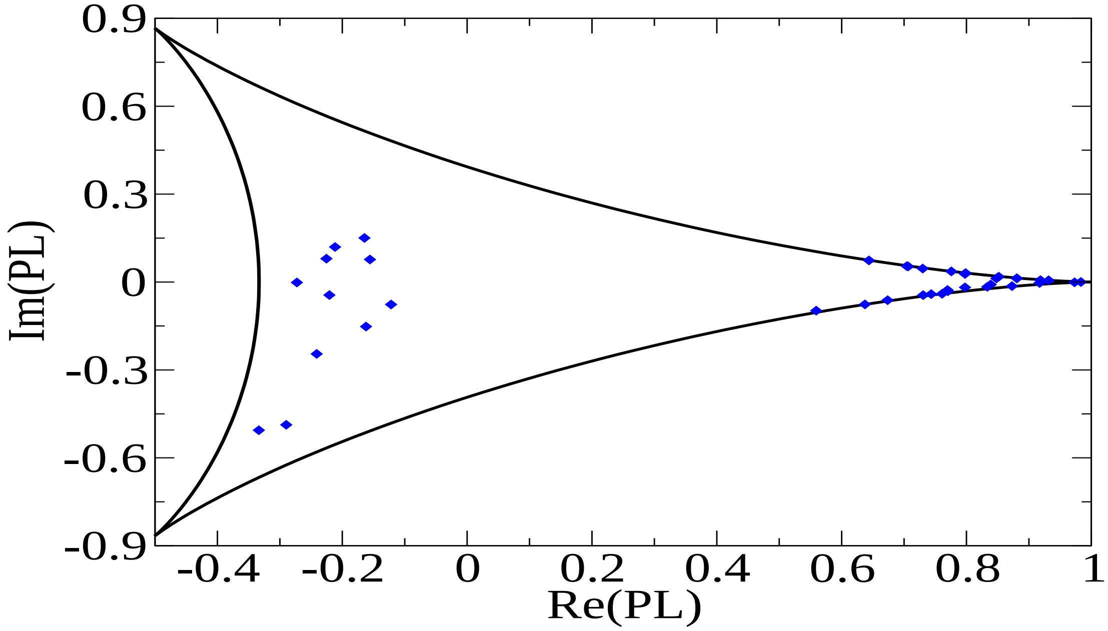
phase	N_{mon}	N_{moncl}	N_{loop}	N_{loopcl}
$T = 0.79\ T_c < T_c$	306(6)	94(3)	45(1)	19(1)
$T = 1.27\ T_c > T_c$	130(3)	21(2)	21(1)	5.2(4)
$T = 1.5\ T_c > T_c$	106(3)	19(1)	18(1)	5.9(4)



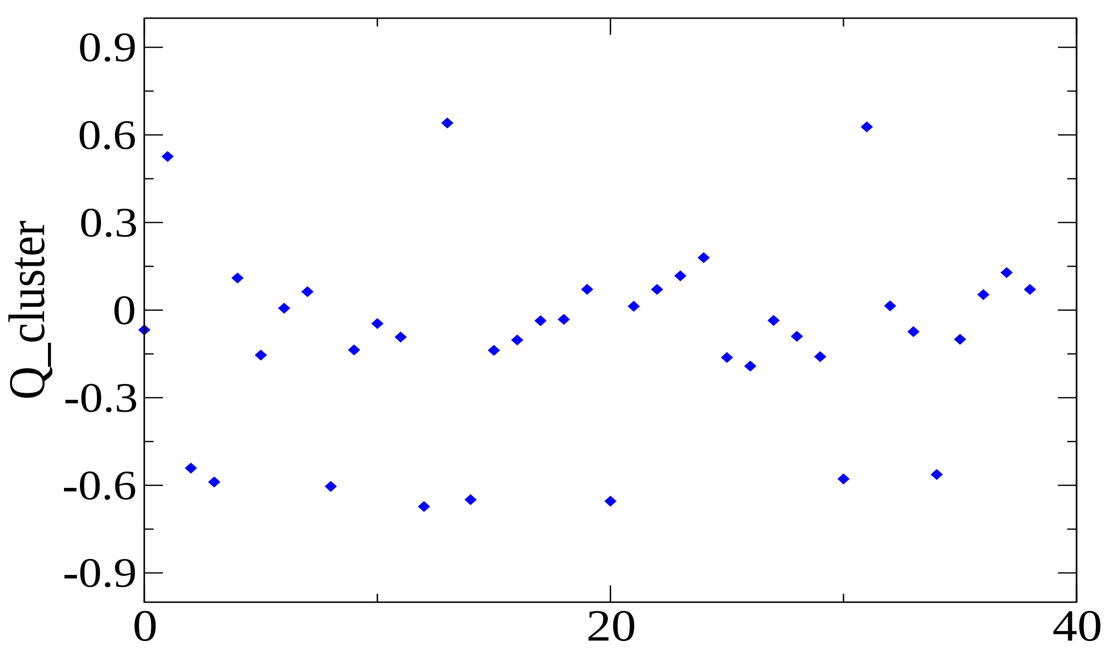
Polyakov loop values at points with $\min(m_1(x), m_2(x), m_3(x))$



Integrated topological charges of these clusters for 12 presented configurations



Polyakov loop values at points with $\min(m_3(x))$ or $\min(m_1(x), m_2(x))$



Integrated topological charges of these clusters for 12 presented configurations

phase	$\rho_3(1)$	$\rho_3(2)$	$\rho_3(3)$
$T = 0.79\ T_c < T_c$	0.093	0.093	0.093
$T = 1.27\ T_c > T_c$	0.09	0.12	0.12
$T = 1.5\ T_c > T_c$	0.044	0.25	0.25

Conclusions:

- We have studied the topological structure of $SU(3)$ gluodynamics by cluster analysis of the gluonic topological density
- The gluonic topological charge density was emerging in the process of gradient flow with respect to the over-improved action
- Monitoring the IPR of the modulus of the topological density has allowed us to stop the gradient flow at the moment when calorons have dissociated into dyons due to over-improved character of this process
- This has given us the possibility to visualize all three dyon constituents of a KvBLL caloron

formed in the gluonic field

- The time-like Abelian monopoles and the specific KvBLL pattern of the local holonomy (untraced Polyakov loop) are correlated to topological clusters
- The reconstructed (summed) values of topological charges for each kind of dyons are concentrated near 1/3 in the confined phase
- In the deconfined phase, however, the values of the cluster charges (characterizing heavy and light dyons) have been found correlated with the local holonomy
- The suppression of heavy dyons with the increase of temperature is clearly seen