Chimera states in two interacting populations of nonlocally coupled 
Stuart-Landau oscillators

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Chimera states are intriguing spatiotemporal patterns co-
existing with synchronized and desynchronized oscillations 
and it has brought out considerable attention towards the 
study of coupled networks with nonlocal topology. Such a 
remarkable phenomenon was initially found in nonlocally 
coupled identical oscillators [1]-[2]. Another interesting 
pattern, that is imperfect chimera state has also been re-
ported with coupled pendula and this state is characterized 
by a certain small number of solitary oscillators (solitary 
state) which escape from the synchronized chimera’s clus-
ter (where solitary oscillator represents a single repulsive 
oscillator splitting up from the fully synchronized group). 
Such escaped oscillators oscillate with different average 
frequencies [3]. A novel mechanism for the creation of 
chimera states via the appearance of the solitary states is 
also reported in Kuramoto model with inertia and with time 
delayed feedback oscillators.

In this talk, we discuss different kinds of imperfect 
synchronized states and chimera states (for spatially pre-
pared initial conditions) in two interacting populations of 
nonlocally coupled oscillators. The imperfect synchronized 
state is characterized by certain small number of solitary os-
cillators exhibiting quasi-periodic oscillations which escape 
from the synchronized group.

Figure 1: (Color online) Space-time plots of the vari-
able $x_j^{(1,2)}$ for mixed imperfect synchronized state (a) 
for population-I and (b) for population-II. Corresponding 
oscillator average frequencies of (c) population-I and (d) 
population-II. Parameter values: $c = 5$, $\sigma = 0.1$, $\eta = 0.25$, 
$\omega = 1.0$ and $r = 0.1$.

Taking into account the above facts, we discuss the dy-
namics of nonlocally coupled two interacting populations of 
Stuart-Landau oscillators. We analyze how does the 
nonisochronicity parameter ($c$) affect the emergence of dif-
ferent kinds of imperfect synchronized states and chimera 
states in such a system with nonlocal coupling. We find that 
for given strengths of inter- and intra-population couplings 
the emergence of imperfect synchronized states for suf-
ficiently smaller values of nonisochronicity parameter ($c$) 
which means that the synchronized and escaped oscillators 
from synchronized state exist within population-II while 
the population-I remains synchronized. By increasing the 
strength of this parameter, we find that the synchronized 
oscillators from both the populations get locked to a com-
mon average frequency while the solitary oscillators are 
distributed with random average frequencies and we term 
such a state as a mixed imperfect synchronized state and is 
demonstrated with space-time plots in Figs. 1(a,b) and av-
gerage frequency profiles of the oscillators in Figs. 1(c,d). In 
addition, synchronized oscillators exhibit periodic motion 
around the origin, whereas the desynchronized oscillators 
exclude quasi-periodic motion but their center of rotation 
is shifted from the origin. In this region, for spatially 
prepared initial conditions, we can observe the coexistence 
of synchronized and desynchronized oscillations in both 
the populations, namely mixed chimera states, which is 
distinct from the results discussed in Ref. [4] where the 
chimera state represents the complete synchronization in 
one population while desynchronization occurs among the 
oscillators in the other population under global coupling. 
We also observe that the imperfect synchronized states can 
drift with time by increasing the parameter $c$. We also 
find that these states are robust against an introduction of 
frequency mismatch between the natural frequencies of 
the population with significant values of nonisochronicity 
parameter.

Full paper published in K. Premalatha, V. K. Chand-
E 94, 012311 (2016).

References