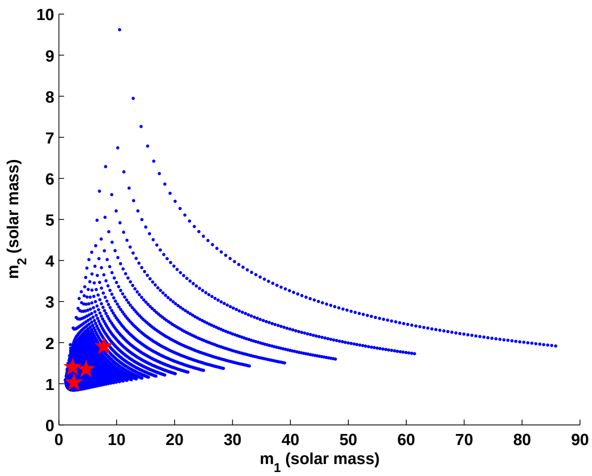

FIG. 2: The region in the m_1, m_2 plane corresponding to the physically valid part of the τ_0, $\tau_{1.5}$ plane. The region is indicated by taking a regular grid of points in the τ_0, $\tau_{1.5}$ plane and mapping them to the corresponding values of m_1, m_2, where by convention $m_1 \geq m_2$. The $\star$ markers shows the signal locations used in the simulations.

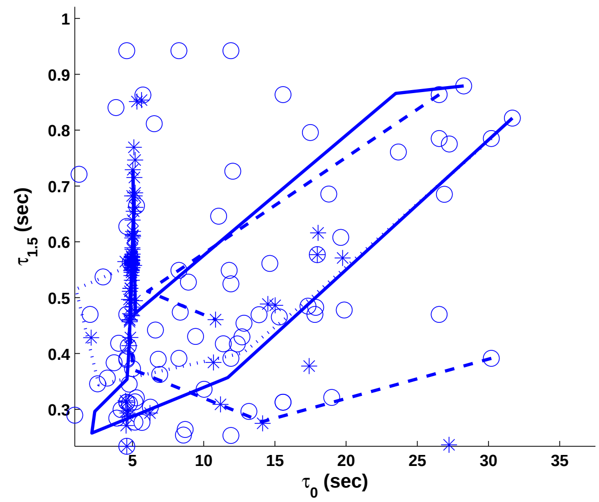

FIG. 3: Evolution of a swarm in the presence of a signal. The '$\circ$' and '$*$' markers show the *pbest* locations of $N_p = 81$ particles when 5% and 60% of the total number of steps were completed respectively. The lines show the paths followed by the *pbest* locations of 5 representative particles between these two steps. With time, the *pbest* locations tend to congregate around the ridge-like feature produced by a signal.

V. RESULTS WITH SIGNAL PRESENT

In this section, we describe the results of simulations performed with signals added to data. We quantify the performance of PSO at four different values of signal SNR and four different locations in the τ_0, $\tau_{1.5}$ plane,

$$\begin{aligned} \mathrm{SNR} &\in \{9.0, 8.0, 7.0, 6.0\} , \\ (\tau_0, \tau_{1.5}) &\in \{(5.0, 0.6), (10.0, 0.75), \\ &\quad (16.0, 0.762), (20.0, 0.9)\} . \end{aligned}$$

(The units for both τ_0 and $\tau_{1.5}$ are in seconds). The corresponding masses (in $M_\odot$) of the binary components are, respectively, $\{(m_1 = 7.78, m_2 = 1.91), (4.71, 1.35), (2.40, 1.40), (2.61, 1.03)\}$. Fig. 2 shows the physical part of the search region mapped into the m_1, m_2 plane along with the signal locations.

For each combination of signal location and SNR, 50 independent data realizations are generated. The length of each realization is 64 sec, with $\delta_s = 1/2048$ sec, and the signal is added at an offset of 10 sec from the start.

A. Qualitative changes induced by a signal

It is instructive to observe how a signal affects the behavior of the swarm. In general, the presence of the signal leads to a broadening of the peak in the fitness function. As is well known, the broadening is more pronounced in one direction, due to the correlation between estimation errors, leading to the appearance of a thin ridge-like feature (c.f., Fig 1).

The particles begin by moving randomly in the parameter space but each time a particle crosses the ridge, its *pbest* tends to fall closer to the flanks of the ridge. As time progresses, the *pbest* of all particles cluster around the ridge. This increases its attractive power in the acceleration of the particles, progressively drawing more particles into exploration of the fitness function along the ridge.

Fig. 3 shows snapshots of PSO at different stages in the search and the progressive clustering of *pbest* locations is seen clearly. A key point to note here is that no prior knowledge is built into PSO about the ridge-like feature. It is found by the particles as they explore the search region.

B. Figures of merit

In order to quantify the performance of PSO in the presence of a signal, we look at two figures of merit. The first is the probability of clustering defined in Sec. IV A. Since the tuning procedure requires a minimum value of 90%, the probability of clustering in the presence of a strong signal should be significantly higher but it should be consistent with the pure noise case for weak signals.

When a signal is added to the data, we do not need the consistency of clustering criterion of Sec. IV A in order to confirm the association of a cluster with the global maximum. Since we know the location of the signal and since the expectation of the fitness function must be maximum at that location, it suffices to check if the maximum fit-