

LSC Progress Report

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Extended hierarchical search for inspiraling binaries

The earlier hierarchical scheme developed by Mohanty and Dhurandhar used the two masses of the constituent stars for implementing hierarchy. This scheme is currently being implemented by the Upper Limits Inspiral Group. The improved scheme extends the hierarchy to yet another parameter, namely, the time-of-arrival so that the hierarchy is now carried out over three parameters. This procedure is expected to reduce the cost by a factor of 4 or 5 over the Mohanty Dhurandhar search and by a factor of *about a 100 over the flat search*.

The essential idea is to carry out the search in two steps:

- (i) Trigger stage: the parameter space is coarsely sampled along with a low threshold;
- (ii) Follow up the first threshold crossings with a fine search with a high threshold.

In the last six months, it was found that the ideal gain factor is reduced, when one takes into account the deemed boundaries of the parameter space. This is because the first stage templates 'go out' of the parameter space near the tapering end of the parameter space resulting in inefficient tiling in this region. Secondly, there is differential rotation between successive templates. Both these effects contribute in reducing the cost gain factor. For the mass range of 1 to 30 solar masses for each component of the binary, the cost gain factor was estimated to be about 70.

A paper on this work has been written, which has now appeared in CQG in the issue of April 2002.

Placement code: An algorithm for the placement of templates in the first stage of the hierarchy has been developed. The shape of the contours at the minimal match of .8, for the 256 Hz upper cut-off is qualitatively much different than those with 1024 Hz upper cut-off. While for the 1024 Hz cut-off, the contours are peanut shaped, for the 256Hz cut-off they are more irregular in shape and two to three times bigger in area. The reason is that the post-Newtonian 1.5 and 2 order terms decay relatively slowly in frequency, giving rise to differences in the contours. This entailed designing our own placement code for the coarse bank. Our algorithm gives about 490 templates for the first stage for the mass range mentioned above. It takes into account the boundary effects, rotational effects and places the templates (inscribed rectangles) with minimal overlap. For the fine search we were able to use the LAL routines, which essentially place a fine rectangular grid around the crossings. The fine search extends up to the neighbouring templates. The cost gain factor is about 60-65.

Our current task is to perform Monte-Carlo simulations. Preliminary results show that several templates 'click', that is, there are multiple crossings of the first stage threshold for an observable signal. This would drastically undermine the advantage of the hierarchy. Our current efforts are focused on 'condensing this cloud' of events into a single event so that the advantage of the hierarchy is not lost.