Periodic oscillations in a string of camphor infused disks - supplemental information

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§-I Preparation of a filament

As mentioned in the main manuscript, the filament consisted of an ensemble of 18 paper disks stitched together by a mono-filament nylon thread. Two holes were made in each paper disk using a needle and the nylon thread was passed through both of them. The resultant filament (Figure SI-1(a)) was then soaked in a solution of camphor and ethanol and subsequently dried to leave camphor infused into the paper matrix of each disk. The top view of the filament during an experiment is shown in Figure SI-1(b) where the filament is illuminated under both UV and visible light. The visible light sources were switched off after the placement of the filament on water. The string made of such camphor infused disks has a finite bending stiffness, originating from both the flexural rigidity of the nylon string, and the non-overlapping condition of adjacent disks. The individual disks then can be considered as discrete points of activity along a continuous filament.

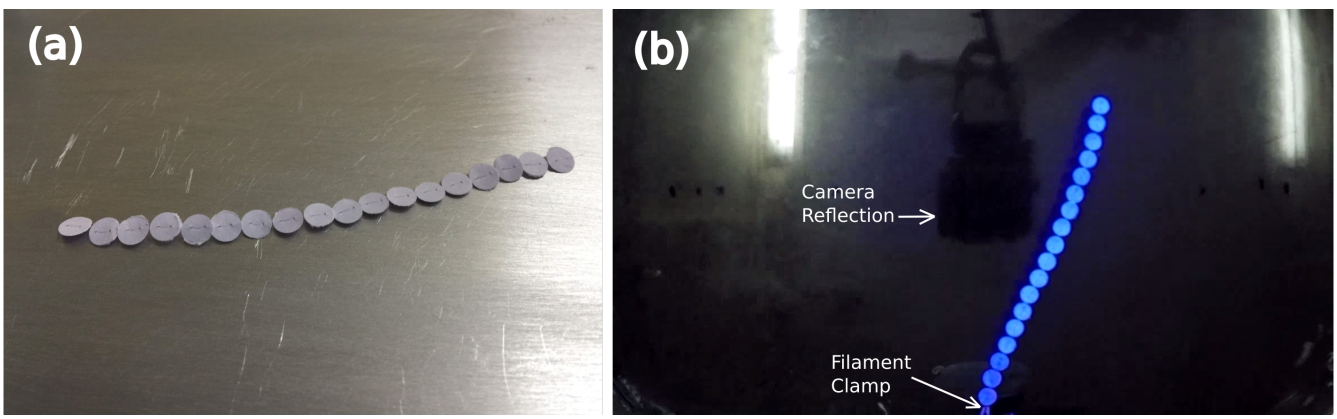

Figure SI-1: (a) A filament consisting of paper disks stitched together by a monofilament nylon thread. (b) Top view of the filament under UV and visible light illumination. The reflection of the video camera is also visible in the water. The visible light sources were switched off after the placement of the filament on the water surface.

§-II Dependence of activity on the infusing camphor concentration

The activity of a filament is positively related to the camphor concentration in the solution used to soak the filament. We test this by plotting the maximum speed attained during our experiments by each disk of the filament for both 1M and 2M camphor concentrations (Figure SI-2). The maximum speeds are plotted as a function of arc length (s) of the filament, where $s = 1$ denotes the particle closest to the clamp, while $s = 18$ is the disk at the free end of the filament. One can see that the disks infused with a 2M camphor solution have a significantly higher maximum speed compared to the disks at the same filament position but infused with a 1M solution of camphor in ethanol.

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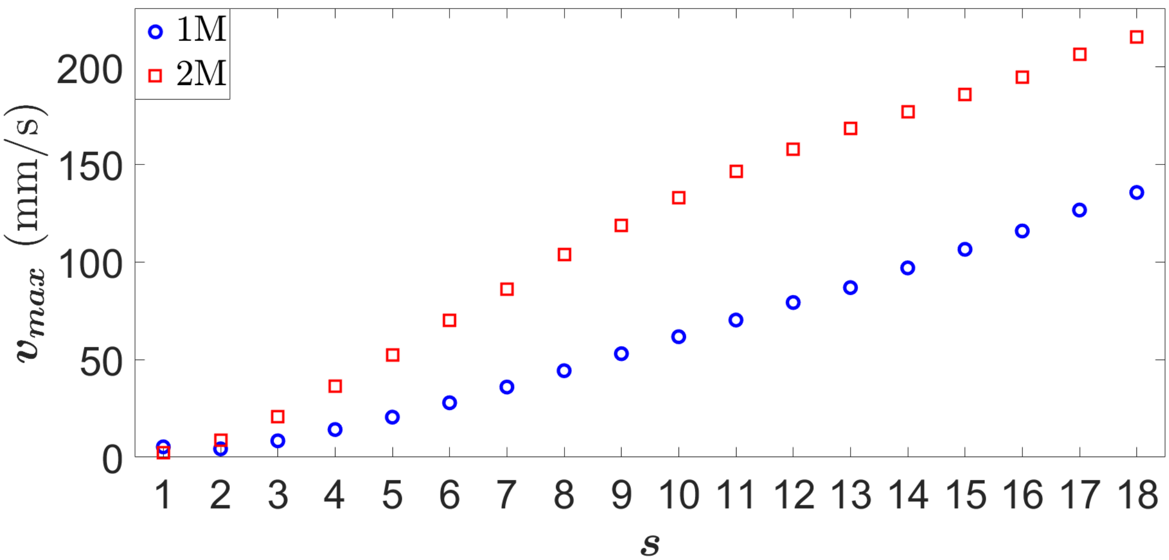

Figure SI-2: Maximum speed of the disks (v_{max}) at each position of the filament for two different camphor concentrations. Disks infused with 1M (blue circles) camphor solutions have significantly lower speed than the disks at the same filament position but infused with 2M (red squares) camphor in ethanol solution.

§-III Factors affecting maximum curvature of a filament

The camphor disks interact with each other via the camphor concentration fields that each disk generates. The disks move due to surface tension gradients created by the camphor molecules on the water surface. The maximum curvature of the filament is dependent significantly on the following factors:

- **Active force:** If the active forces acting on the filament increase, the filament has to correspondingly increase its curvature to balance the forces at the extrema.
- **Distance between disks:** As the distance between the disks increases, the maximum curvature possible for the filament would increase. This is due to the lowering of the bending rigidity of the thread as the unsupported length of the filament increases (Figure §-III). In this work, we use the shortest possible distance between adjacent disks by stitching them right next to each other to construct the filament.

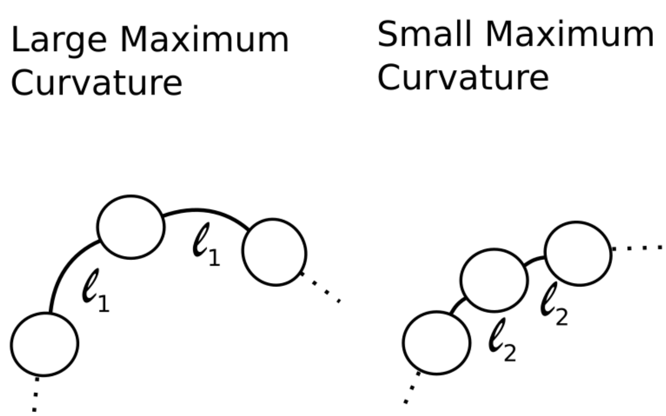

Figure SI-3: When the length of unsupported thread between two disks is large, the maximum possible curvature will be large.

- **Flexural rigidity of the thread:** A softer thread would have comparatively lesser bending rigidity and would therefore allow larger maximum curvature before the filament reverses its direction.

§-IV Sensitivity to Initial conditions

The heatmap shown in Figure SI-4 shows the detailed scan of the simulated filament dynamics as a function of κ_a and β. This figure is complementary to Figure 6 of the main manuscript but with the initial polarity changed to being parallel to the local tangent towards the base of the filament.

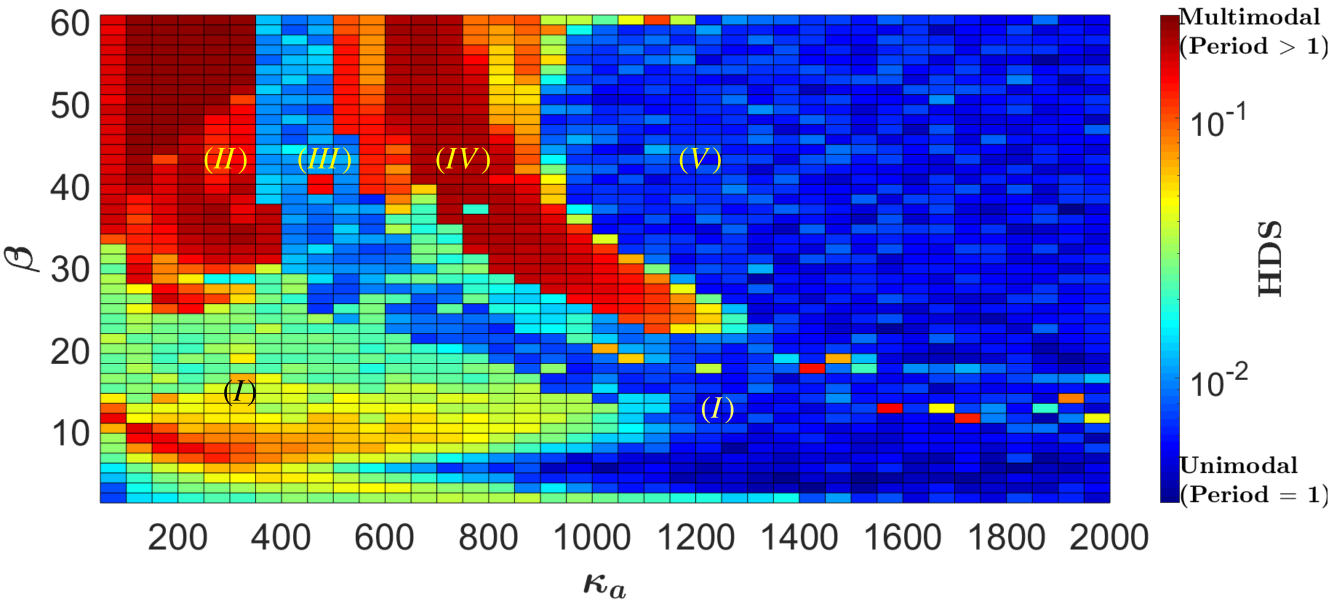

Figure SI-4: Different oscillatory states observed in the parameter space defined by the reorientation rate κ_a, and activity number β. The colour code indicates Hartigan's Dip statistic (HDS) for multimodality. Warmer colours indicates higher level of multimodality. Region I indicates the regular sweeping motion while region -II denotes the mixed sweeping-and-fluttering motion. We observe regular, high frequency fluttering in region III which is sensitive to the initial polarity of the filament. Inside region IV, the filament shifts its mean position to a non-vertical axis. In region V, the filament again exhibits pure fluttering dynamics.