Periodic forcing of a model sensory neuron

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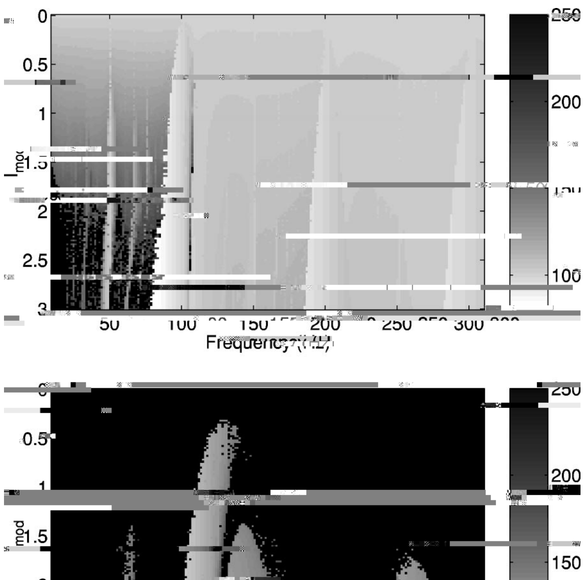
how these other systems respond to time-varying inputs. It is likely that this information would also help in understanding how coupled bursting systems behave, an area of recent interest [19]. Here we choose to study the ghostburster, as it is well characterized experimentally and has a clearly defined and relevant periodic input.

A two-variable model of the bursting pyramidal cell stud-

III. SINUSOIDAL INPUT

We now investigate the effects of sinusoidally modulating the somatic input current to the ghostburster, replacing



[redacted]

his
ented
the 1:1
subcritical

tween periodic
$_{mod}\neq 0$. It is de-
encies and to higher
suggests that if I_{mod} is
nonzero value, the neuron
periodic firing to bursting,
e value of I_b and the forcing
of these types of behaviors are
here a sinusoidal modulation of I is
red milliseconds. In Fig. 5, the burst-
most immediately and the neuron is in-
e same frequency as the forcing. In Fig. 6,
y doublet occurs within 100 ms of the onset
e now examine the effects of including noise in
cs of the ghostburster.

IV. STOCHASTIC RESONANCE

Stochastic resonance is a well-known phenomenon in nonlinear dynamical systems [27,28]. Put simply, the addi-

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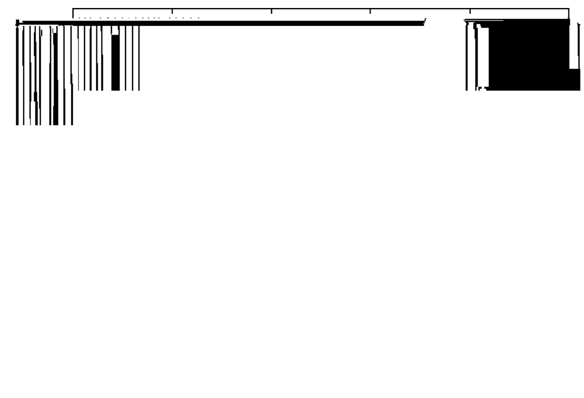

FIG. 5. A transient sinusoidal modulation of the input current switches system (A1)–(A6) from bursting to periodic firing. Parameters are $I_b=9$, I_{mod} is 1.5 for $1200<t<1400$, and the forcing frequency is 125 Hz. Top, V_s and $I-90$; bottom, p_d

[redacted]

ise to a system receiving a sub-
e the signal observable. When no
al is, by definition, unobservable, and
oise are added, the signal is swamped by
f the signal to noise ratio for a periodic
d as a function of noise level, it will have a
t some intermediate intensity of noise. This
may have some functional significance for an
ver'' of the system.

s seen in Fig. 2, the ghostburster (A1)–(A6) has two
rrent thresholds, i.e., there are two values of I such that, if I is transiently increased above these values, there is a qualitative change in the behavior of the system. The first threshold, at $I\approx 5.6$ involves a saddle node on a circle bifurcation, i.e., excitable dynamics between a fixed point and periodic firing, so the system is capable of exhibiting stochastic reso-

nance near this threshold [28]. We now show that the ghost-burster can also show stochastic resonance near the periodic $\rightarrow$ burst threshold that occurs for larger bias current I, provided that bursts are used to form the output signal, rather transient increase in synaptic input to such a model neuron could be robustly signaled by the production of a burst.

The results presented here are for an input signal and noise added to the soma only. Biophysically, however, inputs to a neuron are thought of as coming via the dendrites. Also, it is not clear what relative contribution do the soma and dendrite make to the overall level of noise in a neuron. Thus, it would be interesting to see whether stochastic resonance occurs in the ghostburster when the signal is injected to the dendrite and noise appears in either the soma or dendrite. We investigated these possibilities and found that stochastic resonance does occur, regardless of the location (soma or dendrite

Time is measured in milliseconds and voltages are measured in millivolts. Subscripts s and d refer to somatic and dendritic variables, respectively. m and