**Sehktar** by *JJClark* (2005)

This *Reaktor5* ensemble is a physical model of a *sitar*.
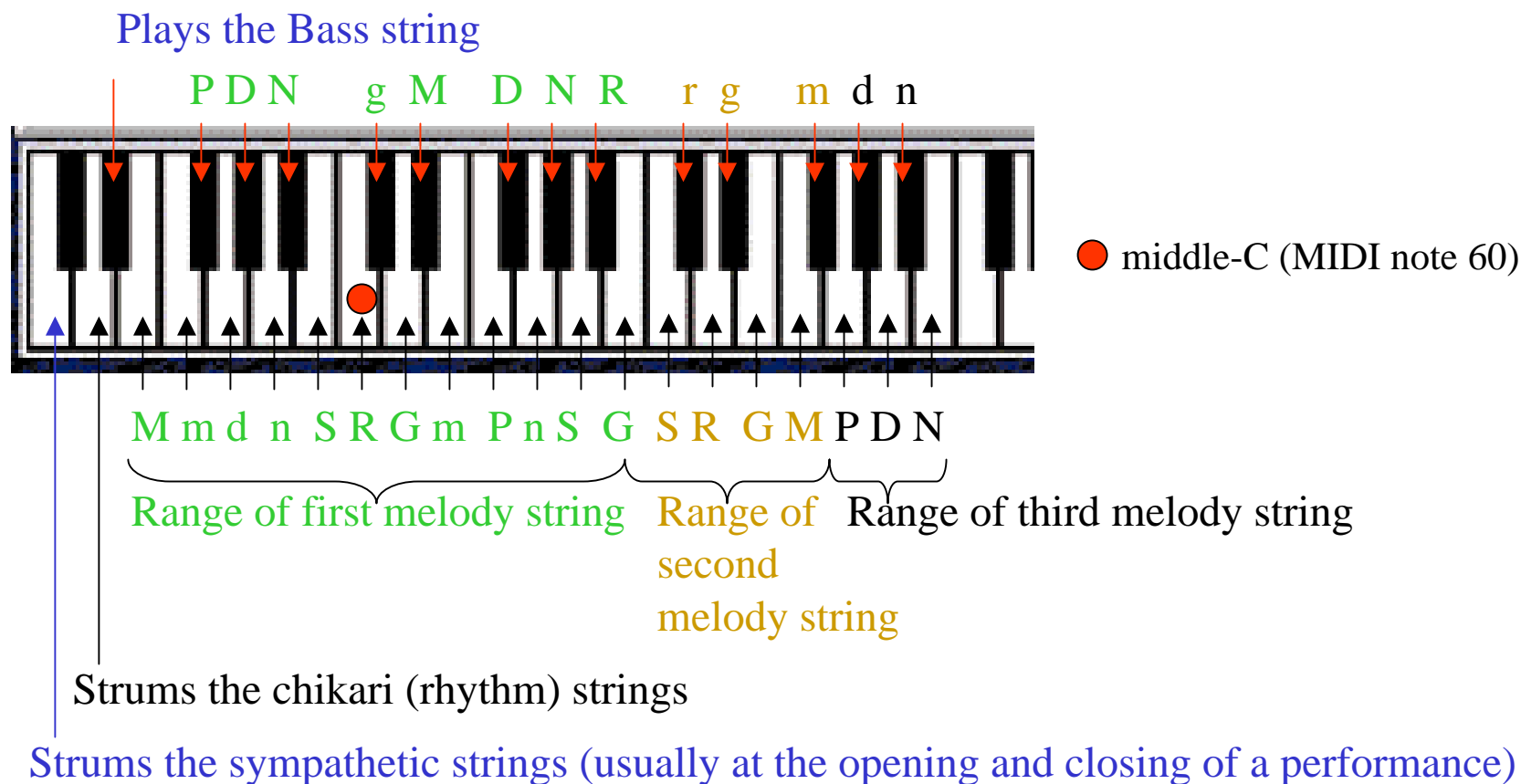
# Physical Modeling Details

The *Sehktar* strings are implemented using delay lines with feedback, similar to the Karplus-Strong string model. Two delay lines are used for each melody string, to model the horizontal and vertical vibrational modes of a real string. The amount of detuning between these two modes can be adjusted with the *Mode Detune* control. The influence of location of the picking point is modeled by altering the spectral components of the noise excitation signal. It can be adjusted with the *Pluck Pos* control. The overall brightness of the string sound is controlled with a lowpass filter, and adjustable with the *Bright* control. The decay rate of the string sound is set by the amount of energy loss in the string, modeled by a lowpass filter in the feedback loop. Decreasing the cutoff frequency of the filter results in a greater damping of the string. The damping of the melody, bass and Chikari strings can be adjusted with their respective *Damp* controls.

The nominal pitch of the string sound is set by the delay time of the delay lines. A pitch envelope raises the pitch slightly, by an amount set by the *Penv* control, when the string is plucked. This models the stretching (increase in tension) of the string when plucked.

The unique buzzy sound of the sitar is due mainly to the nonlinear nature of the bridge. The bridge is curved, which means that the length of the string (and hence its vibrational rate) is dependent on the amplitude of the vibration. As the string vibrates up and down, its end point moves back and forth along the curve of the bridge. This bridge nonlinearity is modeled by modulating the delay line delay times as a function of the string's sound amplitude. The amount of the nonlinear effect is set by the *Jawari* control (Jawari is the Indian name for the bridge).

Finally, coupling between the strings is modeled, and is crucial to obtaining the resonant sound of the sitar. There are two coupling controls, one for coupling between the melody strings and one for coupling between the melody strings and the sympathetic strings.

# Mapping of the MIDI Keyboard to Sehktar Strings and Frets

Plays the Bass string

P D N    g M    D N R    r g    m d n



🔴 middle-C (MIDI note 60)

M m d  n S R G m P n S  G   S R  G M P D N

Range of first melody string    Range of    Range of third melody string
second
melody string

Strums the chikari (rhythm) strings

Strums the sympathetic strings (usually at the opening and closing of a performance)

# Tuning of the Sehktar

The **Sehktar** has 3 main melody strings, a Bass drone string, 2 Chikari (rhythm) strings, and 11 sympathetic strings (many sitars have 7 melody/drone strings and 13 sympathetic strings).

The first two melody strings are always tuned to notes **Ma** and **Sa** from the Indian scale, and the Chikari strings are always tuned to **Sa** and **Sa** one octave up. The tunings of the 3rd melody string and the bass string are adjustable. For **Pancham Karaj**, or **Ravi Shankar**, tuning the 3rd string is tuned to **Pa** two octaves down, and the bass string is tuned to **Sa** two octaves down.For **Vilayat Khan** tuning the 3rd and bass strings are tuned to notes depending on the raga being played (typically the most prominent and next most-prominent notes of the raga). In traditional tuning, the 3rd string is tuned to **Sa** one octave down, and the bass string is tuned to **Pa** two octaves down.

The sympathetic strings are tuned according to the particular raga being played, and usually include all of the notes in the **That** (or mode) associated with the raga. There are 10 **That**s commonly used in Indian music. The ensemble snapshots give examples of the tuning of the sympathetic strings for each of these.

Westerners (like me!) might think that the Sehktar sounds out of tune. That is because its frets are specified so as to give a **naturally tempered** scale. This type of tuning provides purer harmonic intervals, which improves the coupling of the sound of the melody strings to the sympathetic strings.

# Playing Tips

The Sehktar uses a fair amount of CPU cycles. You can change the Sampling Rate to a level that doesn't kill your computer. But I urge you to use the maximum possible sampling rate, as it makes a big difference to the sound. At 44KHz the sound is not too bad, but the sustain and sweetness of the sound is much improved at 88KHz.

Most of the familiar sitar sound comes from effective utilization of pitch-bending (or *Meend*) on the main melody string. Practice makes perfect!

Playing according to the rules of *Raga* is also important in making the Sehktar sound like a Sitar. The right notes must be played, and these are different in rising passages than in falling passages. The sympathetic strings must be retuned according to the raga being played. If they are not, then the notes of the main melody will not all be sustained and resonated as they should.