[Anharmonic](http://dx.doi.org/10.1063/1.2736693) properties of the vibrational quantum computer

 $M_{\rm eff}$ $M_{\rm eff}$ \sim $M_{\rm eff}$ \sim $M_{\rm H}$ \sim M *Chemistry Department, Wehr Chemistry Building, Marquette University, Milwaukee, Wisconsin 53201-1881* Received 29 January 2007; published $\frac{1}{2007}$; published $\frac{1}{24}$ May 2007

 W developed and efficient approach to study the coherent control of vibrational state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-stat $\tau_{\rm c}$ transitions. The approximations employed in the regime of the regime of the regime of the regime of the low vibration specific to the vibration specific to the vibration \tilde{y}_t and \tilde{y}_t approach we explore this approach we explore this approach we explore this approach we explore this approach we explore the vibration o how the vibrational properties of two-qubit system affect the accuracy of subpicosecond quantum $q = \frac{1}{2}$ theory $\frac{1}{4}$ optimal control theory $\frac{1}{4}$

simultaneously by the same single laser pulse $z_{\rm{dust}}$ is replaced by re- $\mathbf{u} \times \mathbf{\tilde{t}} = -\mathbf{u} \times \mathbf{v}$

II. THEORY

As usual, the evolution of the vibration of the vib

 $M_{kl,ij} = \ _0 \ k \ i \ _{Q_1} \ l \ j \ _{Q_2} + \ _1 \ k \ Q_1 \ i \ _{Q_1} \ l$

III. RESULTS AND DISCUSSION

As $e_{\mathbf{d}}$ in the previous section, we vary the values $\mathbf{a}_1, \mathbf{a}_2, \mathbf{a}_1, \mathbf{a}_2, \mathbf{b}_2, \mathbf{c}_3, \mathbf{c}_4, \mathbf{d}_5, \mathbf{d}_6, \mathbf{d}_7, \mathbf{d}_8, \mathbf{d}_9, \mathbf{$ 10 cm $^{-1}$ step sizes, perform the pulse optimization for p CNO_t gates for \mathbb{A} and \mathbb{A} find \mathbb{A} fields \mathbb{A} fields \mathbb{A} considered case. Overall, we performed optimizations on 9 9 9 \hbar \rightarrow $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$ 729 sets of parameters in the parameters in the construction of \mathcal{A} $t_{\rm b}$ \rightarrow $t_{\rm d}$ 3D -s_{plin}e interpretation of *F* between the spline interpretation of *F* between the split F calculated points. Thus, the fidelity *F* can

 $i+1, j \quad 1 \rightarrow i+1, j \quad \lambda$ $N \quad \lambda$ $j \quad 2 \quad \lambda$ also coincide with the frequencies of $i+2$, $j \quad 2 \rightarrow i+2$, *j* 1 transitions, and so one. In Fig. [6](#page-7-0) the so one sets of equivalent solutions. $a = \sqrt{1 + t}$ are used to indicate different state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-to-state-t

tions along the second target mode. The second target mode. The second in \mathbf{r}_i Fig. 5 for the three sets of $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$ discussed in the term of $\frac{1}{2}$ t the previous paragraph. A striking feature of these systems t becomes immediately obvious: The frequencies of *i*, *j* $\rightarrow i,j+1$ transitions for $j \neq 1$ coincide with the frequencies \rightarrow **j** \rightarrow **j** \rightarrow

 m_{eff} defines plane in m_{eff} is m_{eff} in m_{eff} is m_{eff} is m_{eff} is m_{eff} is m_{eff} is m_{eff} parallel to the 1 axis and is perpendicular to the $\frac{1}{2}$, 12 plane. All the lowest fidelity points in the $\mathbf{F} = \begin{bmatrix} \mathbf{0.5} & \mathbf{0.7} & \mathbf{0.7} \end{bmatrix}$ either belong to this plane or are found very close to it, which is clearly seen in Fig. [4](#page-6-0) . Further analysis shows that \mathbf{F} in the vicinity of the fidelity \mathbf{F} such that \mathbf{F} is planet that \mathbf{F} is planet that \mathbf{F} is planet to \mathbf{F} is increases but still remains very poor in the range of F^* 0.60 0.65. $C_{\bf 1}$ and $\bf 1$ and its plane [12](#page-6-1) and its plane 12 an $\mathcal{L} = -\frac{1}{2} \mathbf{h} \mathbf{u} + \frac{1}{2} \mathbf{v} + \mathbf{v}^2 \mathbf{v$ ecule for quantum computation.

$C. A_1/A_2$ plane

The other prominent feature of the data cube is planet for the cube is planet for in the middle of the $A \times I$ region where the value of value of A *F* drops abrupted to *F* 0.985 and **b** for \int illustrated in Fig. [4](#page-6-0) b using data cropping F 0.987 window. I see a very clearly that the this region of \mathbb{R} lower fields is roughly planer, or \mathbf{h} and space near the space \mathbf{h} diagonal line of the ² , ¹² plane, and extends through the entire range of \mathbf{r} are typical points from the 1, 2, 12 = 40,50,50 ¹, $\binom{1}{1}$ 50,90,90 ¹, t 60,115,115 ¹. The last point is especially surprising, $\frac{1}{2}$ because at this point both input \mathbb{R}^n is point both important and \mathbb{R}^n eters become very large very large $\frac{1}{12}=115$ cm $\frac{1}{2}$, but the fidelity remains remains relatively low, $F=0.984$. The transition free transit $\mathbf{q} \cdot \mathbf{q} = \mathbf{q} \cdot \mathbf{q}$ diagrams for $\mathbf{r} \cdot \mathbf{r} = \mathbf{q} \cdot \mathbf{q}$ are given in Fig. 7

and even quick look look at the second look at the second reveals number of \mathbb{R}^n resonant frequencies. Namely, the frequencies of *i*, *j* $\rightarrow i,j+1$ transitions for j 1 coincide with the frequencies j in j $i+2, j \quad 1 \rightarrow i+2, j \quad \lambda$ A \downarrow \downarrow \downarrow F_i. 6. ϕ in ϕ in ϕ in ϕ is A_{μ} in A_{μ} is the interval in A_{μ} $s_{\rm th}$ similar to that shown in Fig. 6 , $s_{\rm th}$, there are two in Fig. 6 , $s_{\rm th}$

 $12 = 2.$ 13

This formula also defines plane in the three-dimensional in the three-d 1, 2, 12×12 space and again it is parallel to the 1 axis and a space and a space and a space and a space of is perpendicular to the 2, 12 plane. This A₁/A₂ plane clearly seen in Fig. [4](#page-6-0) α . Although the \mathbf{F}

effect is given in Fig. [6](#page-7-0) . Here on the transitions in the transition λ , λ , $10 \rightarrow 11$, λ resonance with the 10 \rightarrow

 $\label{eq:R1} \mathbf{R}^{(2)} = \frac{2}{\pi} \mathbf{R} \mathbf{R}^{(2)} = \mathbf{R} \mathbf{R}^{(2)} = \mathbf{R} \mathbf{R}^{(2)}$

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