【结果】



取

s2x =

0.5000 1.5000 2.5000 3.5000 4.5000 5.5000

s2p =

0.5000 1.5000 2.5000 3.5000 4.5000 5.5000





【代码】

clear, clc, close all

m = 1;

hbar = 1;

omega = 1;

k = sqrt(m\*omega/hbar);

phi = @(n, x)sqrt(k) / pi^(1 / 4) / sqrt(2^n\*factorial(n)) .\* hermiteH(n, k\*x) .\* exp(-(k \* x).^2/2);

fprintf("归一化检验：%.16f\n", integral(@(x)phi(10, x).^2, -inf, inf))

% fplot(@(x)phi(0,x),[0,5])

syms x;

x\_mean = @(n)integral(@(x)phi(n, x).^2.\*x, -inf, inf);

p\_mean = @(n)integral(matlabFunction(-1i\*hbar\*sym(phi(n, x))\*diff(sym(phi(n, x)))), -inf, inf);

x2\_mean = @(n)integral(@(x)phi(n, x).^2.\*x.^2, -inf, inf);

p2\_mean = @(n)integral(matlabFunction(-hbar^2\*sym(phi(n, x))\*diff(diff(sym(phi(n, x))))), -inf, inf);

hold on

N = 0:5;

for n = N

fplot(@(x)phi(n, x), [0, 5]);

end

title("一维谐振子的波函数")

legend("n = "+N);

xlabel("$$x$$", "Interpreter", "latex")

ylabel("$$\phi$$", "Interpreter", "latex")

hold off

figure;

N = 0:5;

hold on

s2x = arrayfun(@(n)x2\_mean(n), N)

plot(N, s2x, "ro")

s2p = arrayfun(@(n)p2\_mean(n), N)

plot(N, s2p, "go") % 和上面的图像重叠了

plot(N, s2x.\*s2p, "bo")

plot(N, ones(size(N))\*(hbar / 2)^2, "k--")

title("不同本征值本征态的观测量的平均值")

legend("$$\sigma\_x^2$$", "$$\sigma\_p^2$$", "$$\sigma\_x^2\sigma\_p^2$$", "$$\frac{\hbar}{2}$$", "Interpreter", "latex");

xlabel("$$x$$", "Interpreter", "latex")

ylabel("$$\phi$$", "Interpreter", "latex")

hold off