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# -*- encoding: utf-8 -*-
import scipy, scipy.special
from numpy import *
from matplotlib.pyplot import *

def eikz(k, z, ltrunc, theta):
    r = z/cos(theta)
    ls = arange(0, ltrunc+1)
    coefs = array([(1.j**l)*sqrt(4.*pi*(2.*l+1.)) for l in ls])
    jls = scipy.special.sph_jn(ltrunc, k*r) [0]
    yl0s = scipy.special.sph_harm(0, ls, 0, theta) # (m, l, phi, theta)
    return sum(coefs*jls*yl0s)

def fonte_pequena(leg):
    for t in leg.get_texts():
        t.set_fontsize('small')

def comparar_expansao(ltrunc, theta):
    zs = arange(-3, 3, 0.01)
    # k = 1.
    expansao = array([eikz(1, z, ltrunc, theta) for z in zs])
    exato = exp(1.j*zs)
    subplot(211)
    ylabel(u'valor real')
    plot(zs, real(expansao), zs, real(exato))
    fonte_pequena(legend((u'expansão', u'exato'), borderaxespad=0., loc='upper left'))
    text(2.1, 0.7, r'$l_{max} = %d'%ltrunc)
    text(2.1, 0.5, r'$\theta = %.2f\pi$'%(theta/pi))
    subplot(212)
    ylabel(u'valor imag')
    xlabel(u'z')
    plot(zs, imag(expansao), zs, imag(exato))
    fonte_pequena(legend((u'expansão', u'exato'), borderaxespad=0., loc='upper left'))

def mapa_diferencas(ltrunc):
    mapa_re = zeros((120, 120))
    mapa_im = zeros((120, 120))
    for i in range(120):
        z = (i-60)/20.
        for j in range(120):
            x = (j-60)/20.
            # k = 1.
            dif = eikz(1, z, ltrunc, arctan2(x,z)) - exp(1.j*z)
            mapa_re[i][j] = abs(real(dif))
            mapa_im[i][j] = abs(imag(dif))
    subplot(211)
    imshow(mapa_re, cmap=cm.gray_r, origin='lower', extent=[-3,3,-3,3])
    title(u'Erro do valor real')
    xlabel(u'x')
    ylabel(u'z')
    colorbar()
    subplot(212)
    imshow(mapa_im, cmap=cm.gray_r, origin='lower', extent=[-3,3,-3,3])
    title(u'Erro do valor imaginário')
    xlabel(u'x')
    ylabel(u'z')
    colorbar()

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