P2-5

Reflectors for Therapeutic Vortex Beam Generation

Presenter: Noe Jimenez

Authors in order: Noe Jimenez, *Universitat Politècnica de València*, Enrique González Mateo, *Universitat Politècnica de València,* José M. Benlloch, *Universitat Politècnica de València,* Francisco Camarena, *Universitat Politècnica de València*

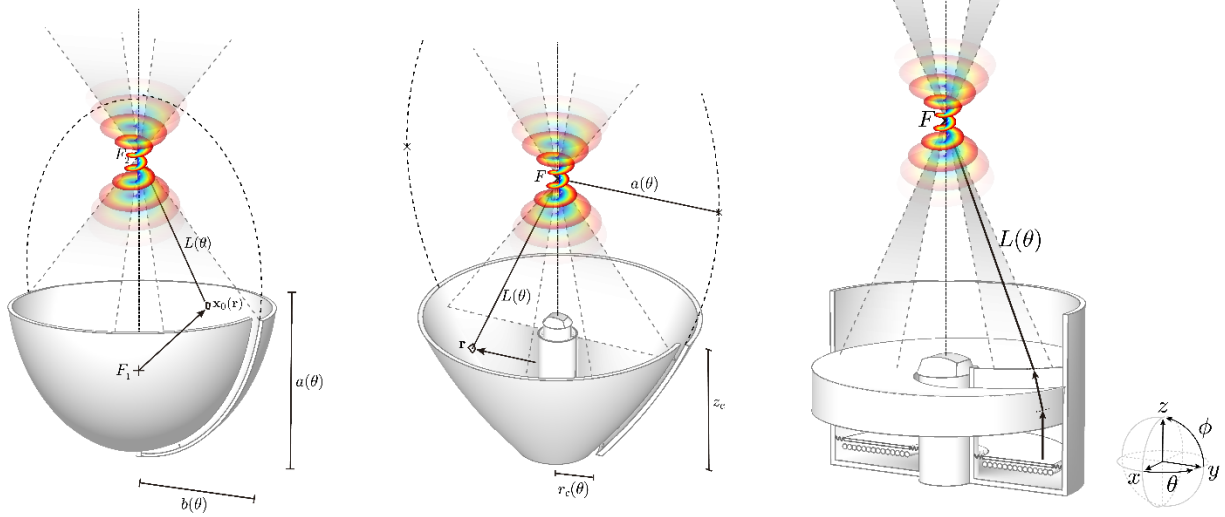
Vortex beams are currently used in many emerging therapeutical ultrasound applications. In this work, we present several reflectors to synthesize focused vortex beams for therapeutical ultrasound.

We present the design equations of several topologies of reflectors to generate focused vortex beams. By using geometrical methods, we derived the parametric surfaces for helico-elliptical vortex reflectors using electrohydraulic sources, helico-parabolical vortex reflectors and convex helicoidal lenses using electromagnetic sources. Using pseudo-spectral time-domain methods, the performance of these topologies is compared with other known vortex generators, such as therapeutical phased array systems or spiral diffraction gratings.

Results show that helico-elliptical reflectors, helico-parabolic reflectors, and helical lenses can generate focused vortex beams containing phase dislocations. The topological charge of the vortices at the design frequency can be tuned by the design equations. We observe that vortices with integer topological charge emerge at the design frequency, while vortices of fractional topological charge are observed at other frequencies. While these structures can focus broadband acoustic vortices, phase dislocations cannot be generated at low frequency and reflected pulses generate vortices of fractional topological charge. The pressure gain of the different vortex generators is compared.

Helico-elliptical and helico-parabolic reflectors efficiently generate focused vortices. While these complex wavefronts can be generated by phased arrays or lenses, the proposed mirrors do not introduce remarkable attenuation and, therefore, they can be used when a large mechanical amplitude is needed, such as in lithotripsy, histotripsy, or particle and tissue manipulation applications.

Research supported by the Spanish Ministry of Science, Innovation and Universities through grants PID2019-111436RB-C22, IJC2018-037897-I. Action co-financed by European Union grant IDIFEDER/2021/004.


F_2
$L(\theta)$
$\mathbf{x}_0(\mathbf{r})$
F_1
$a(\theta)$
$b(\theta)$
F_2
$a(\theta)$
$L(\theta)$
$\mathbf{r}$
z_c
$r_c(\theta)$
F_2
$L(\theta)$
z
ϕ
x
θ
y