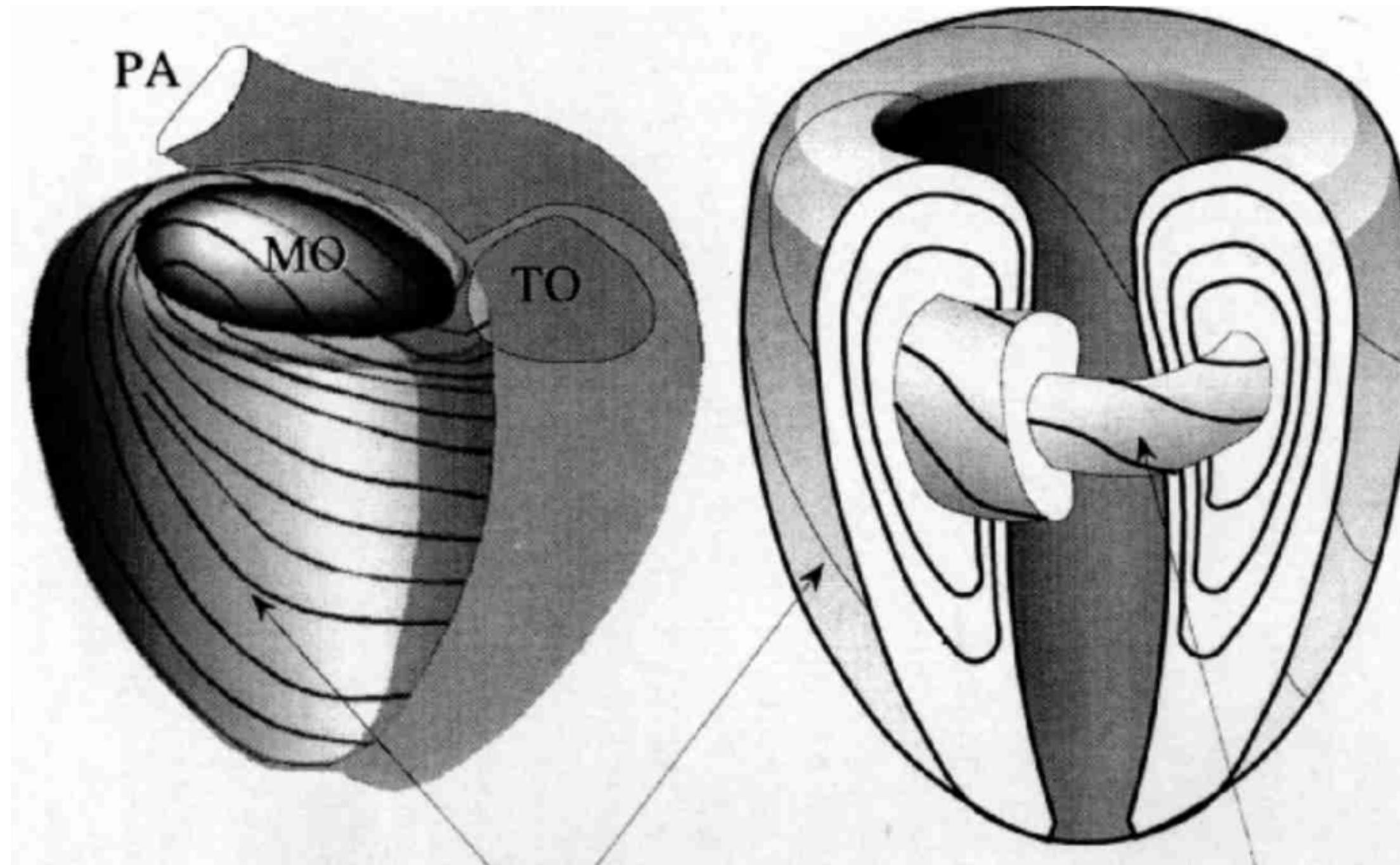


Modélisation de l'hyperbole permettant le déroulé du ventricule droit cardiaque

Ismaël Ait Lhoussaine
Florian Peneau



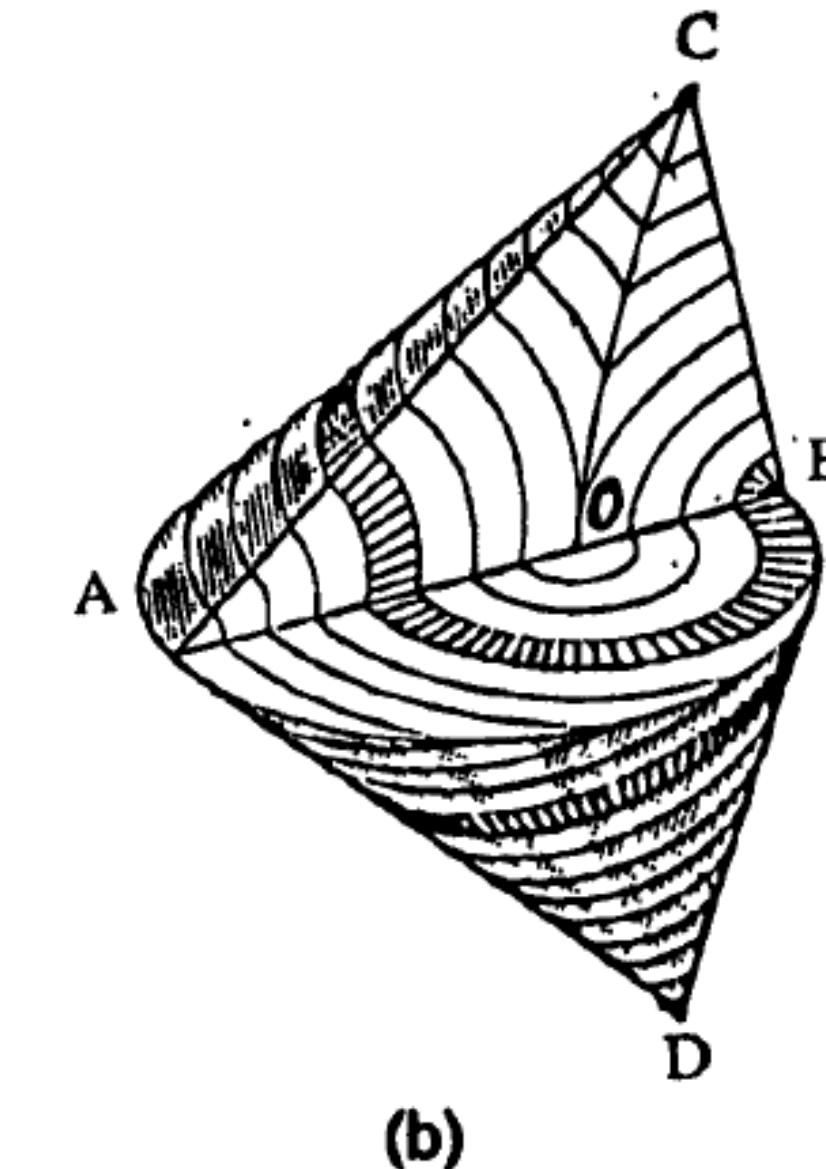
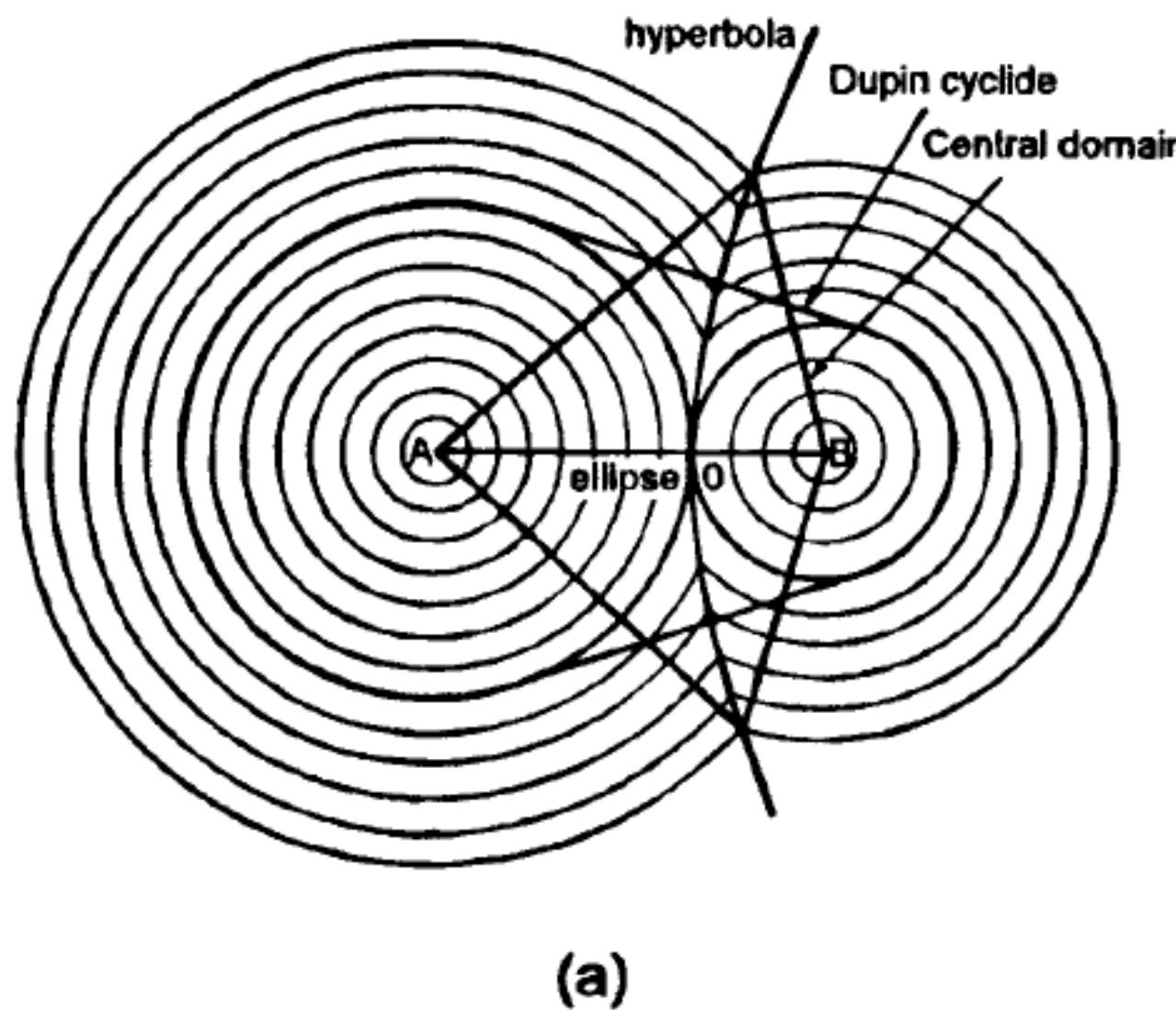
Ventricule gauche



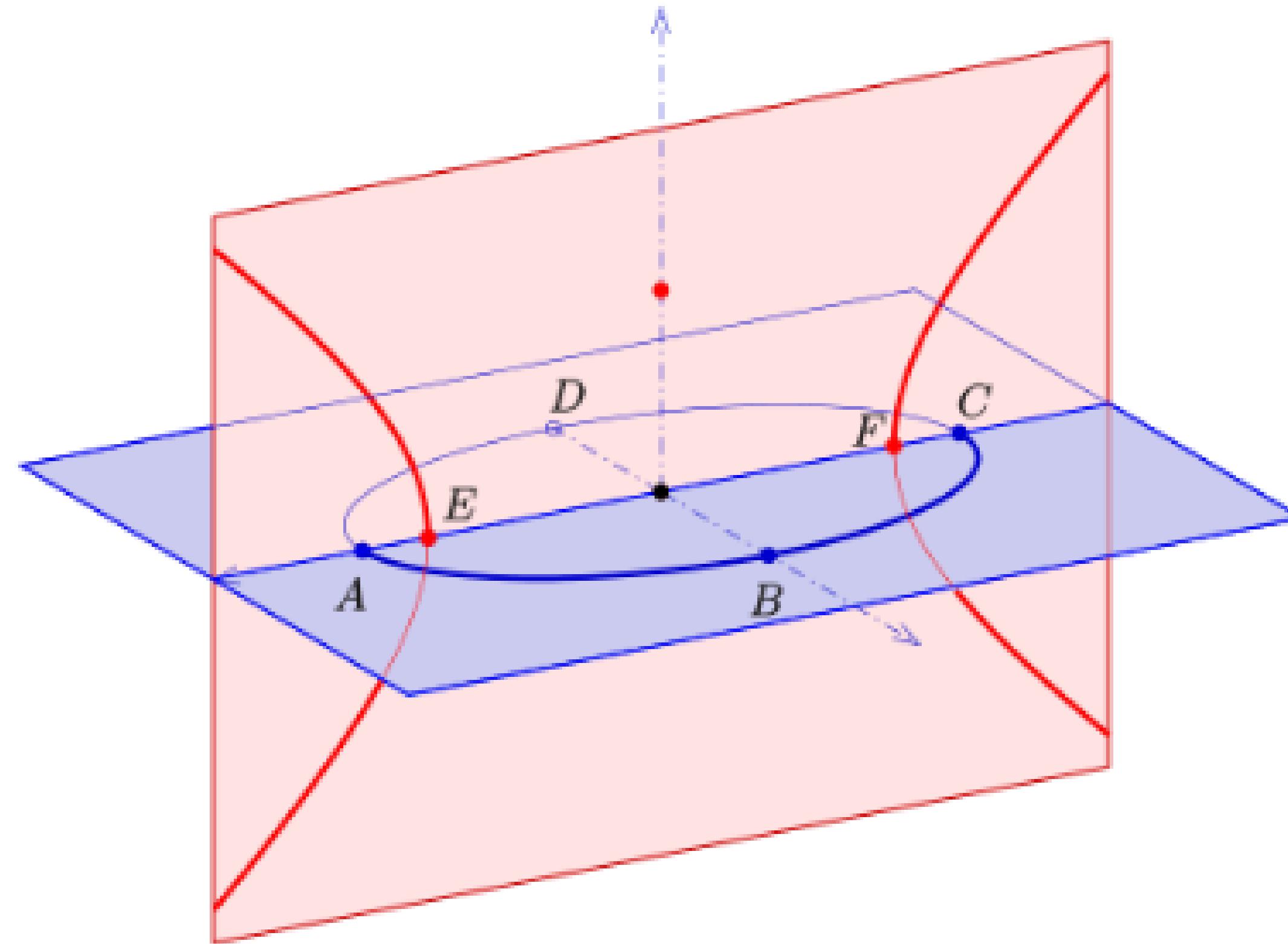
Krehl, 1891

Streeter, 1979

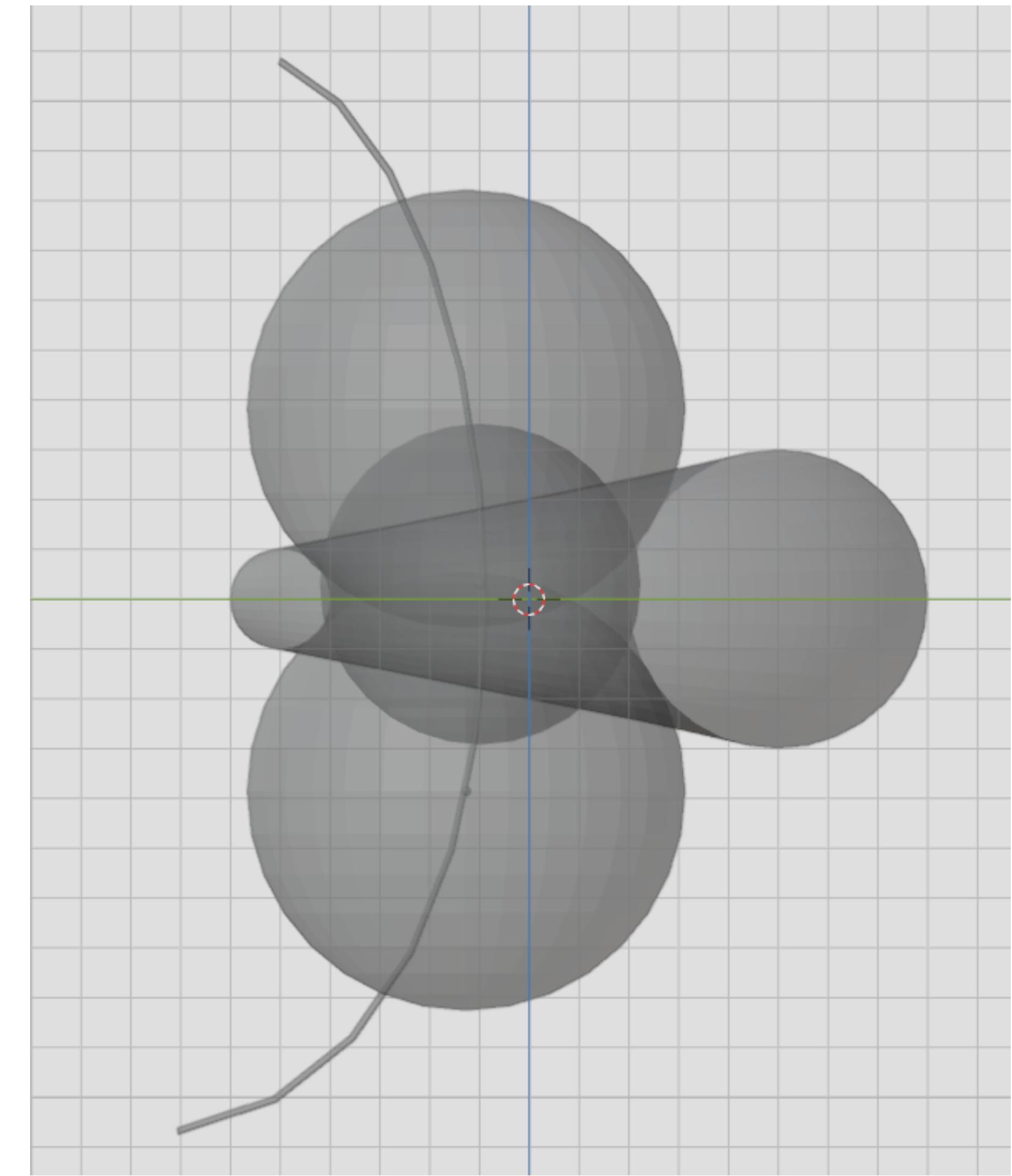
Cyclide de Dupin



Cyclide de Dupin

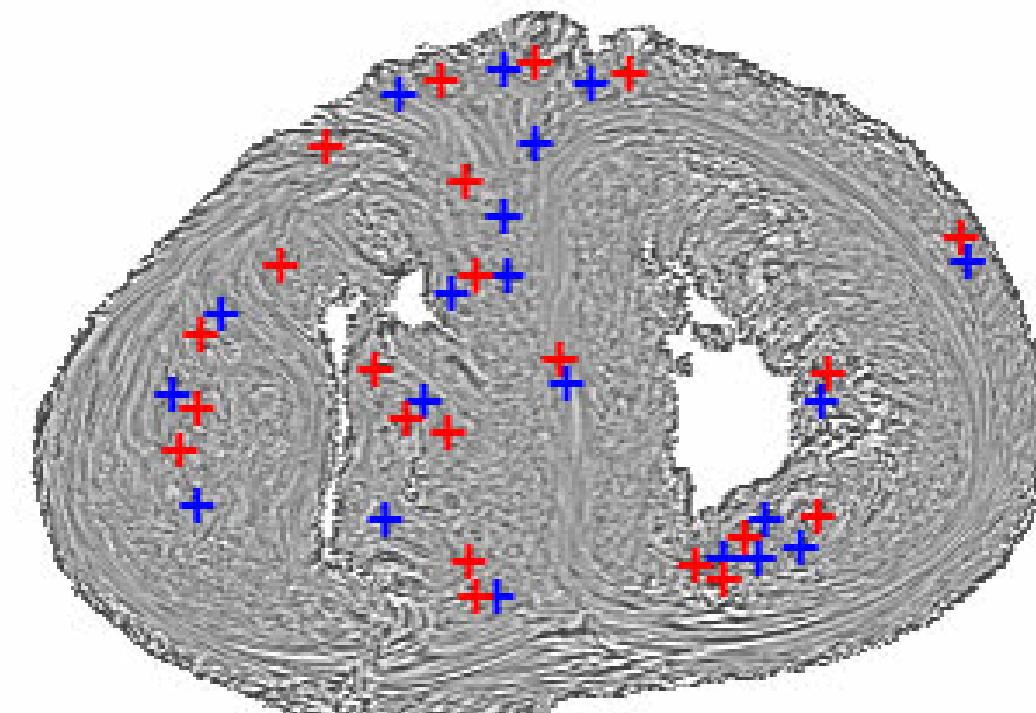
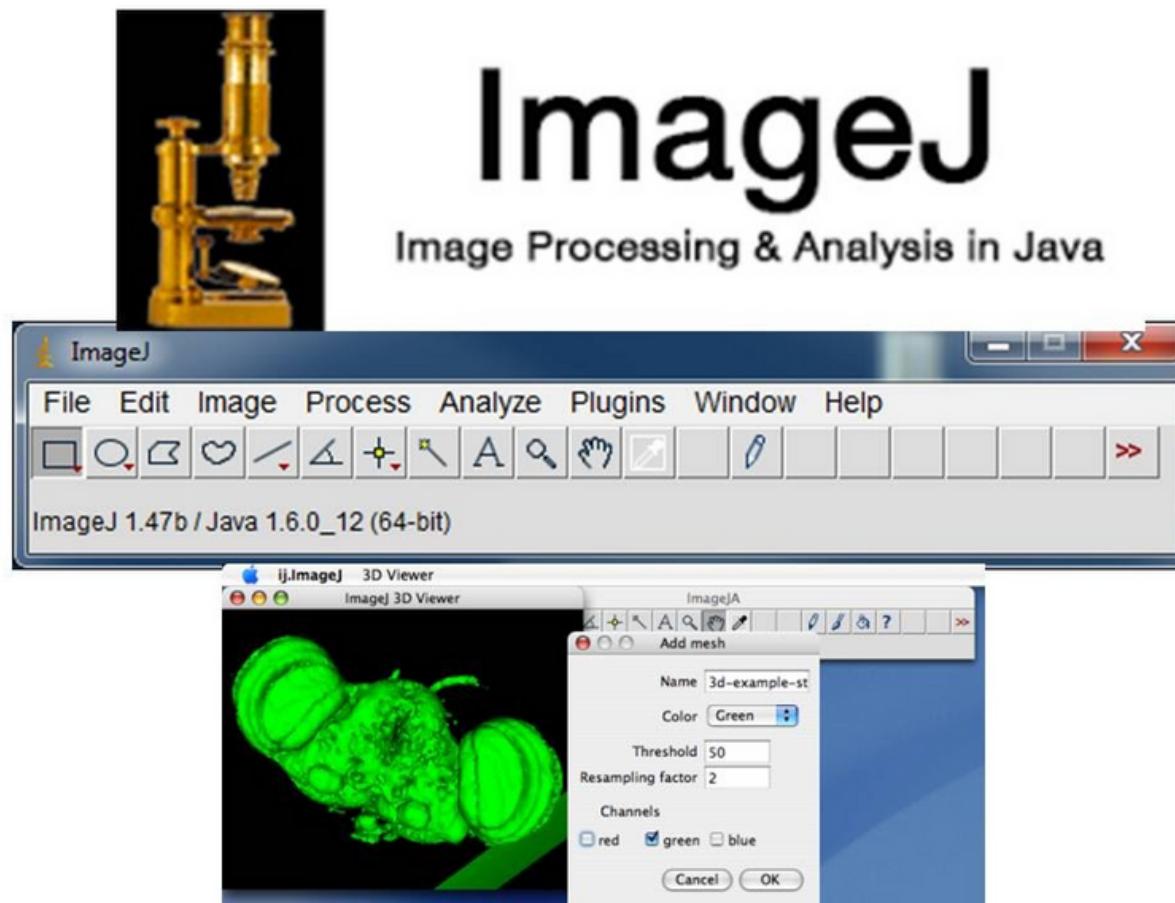


Cyclide de Dupin



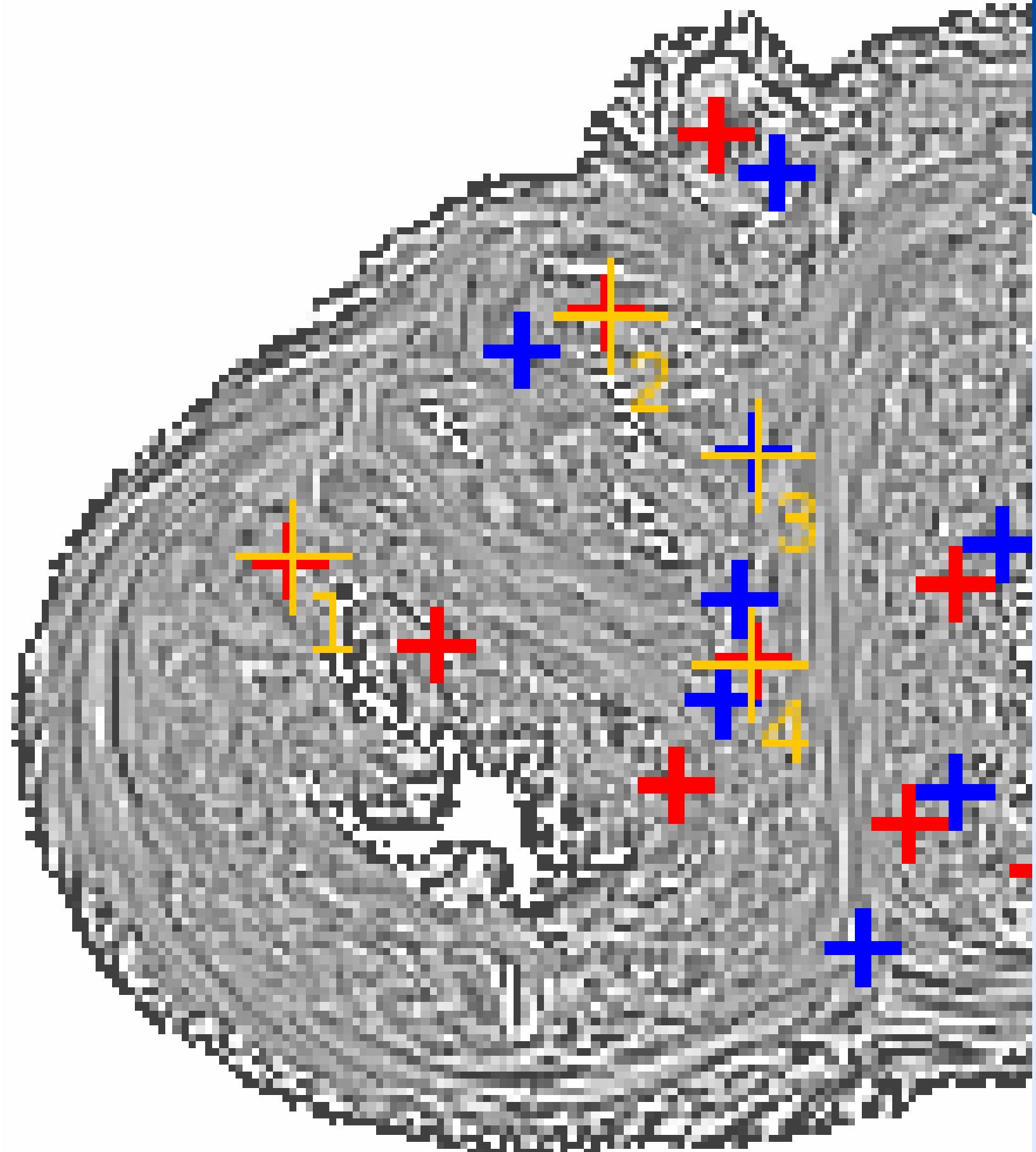
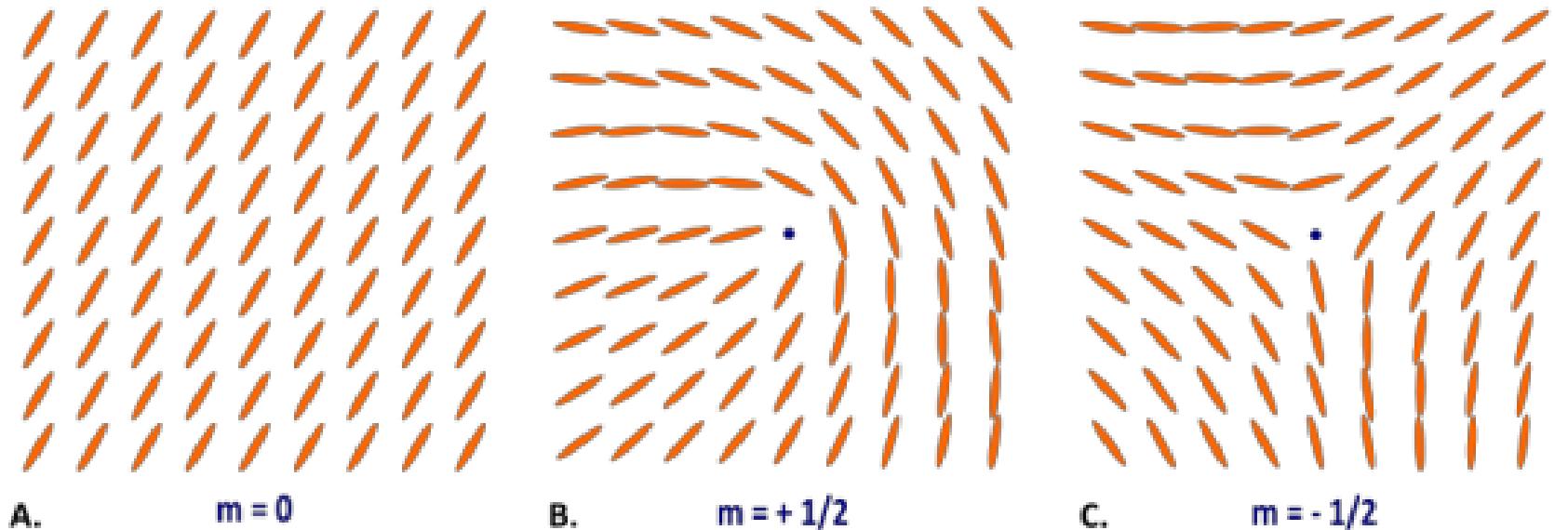
Visualiser les sections du cœur

- Logiciel multi-plateforme libre et open source
- Traitement et analyse d'images
- Développé en Java
- Permet l'ajout de plugins et macro

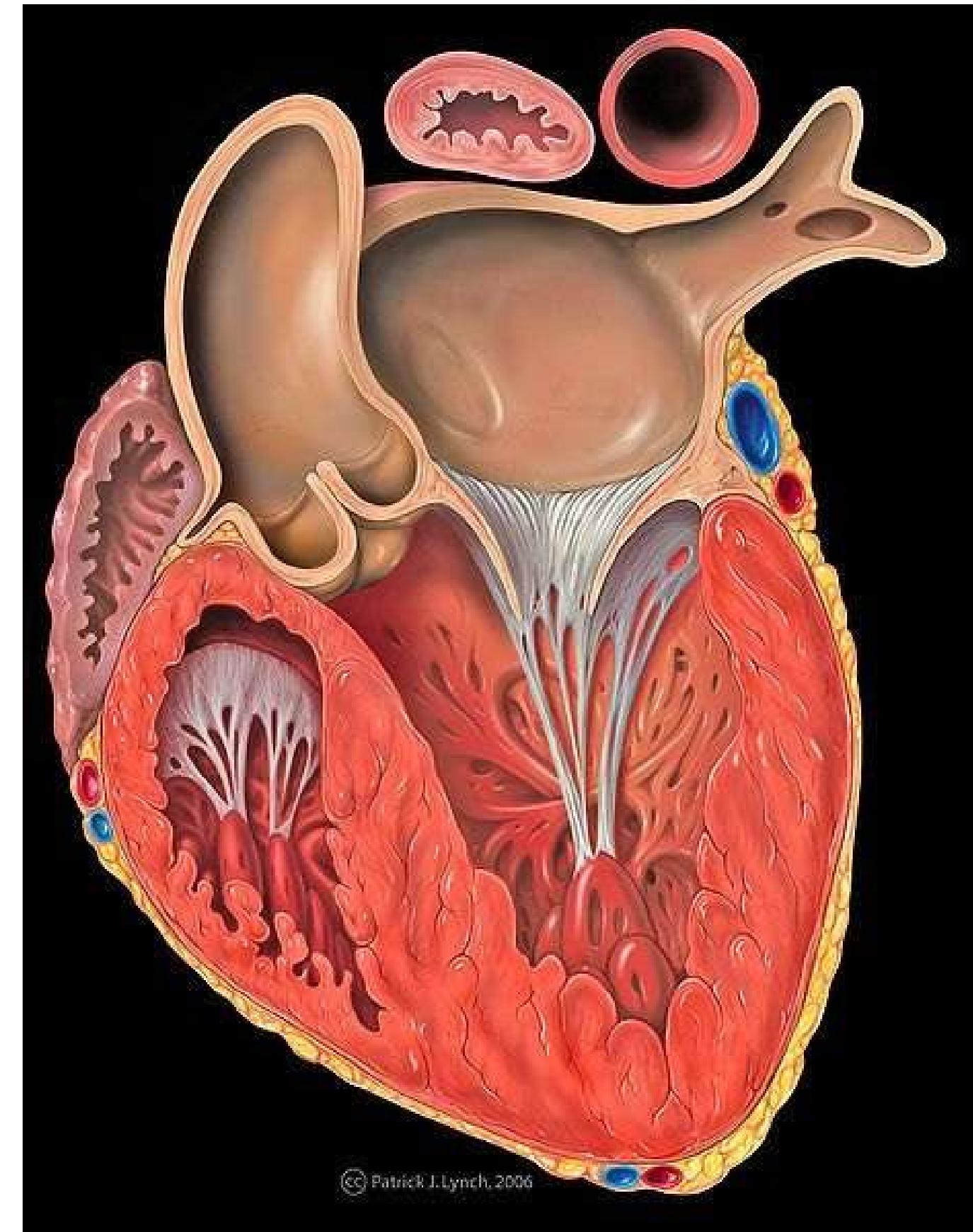


Disinclinaisons

Points où l'orientation des molécules changent
brutalement



Myocarde compact et trabéculé



Représenter l'enveloppe du cœur



Fichier TIFF

Récupérer les coordonnées des pixels blancs

```
setBatchMode(true);
open("/home/aithoui/workspace/imagej/VOLUME.tif.zip");
getDimensions(width, height, channels, slices, frames);
getPixelSize(unit, pixelWidth, pixelHeight);
nom_fichier = "/home/aithoui/workspace/imagej/enveloppe.csv";
fichier = File.open(nom_fichier);
File.close(fichier);
for (plane=1; plane <= slices; plane++)
{
    showProgress(plane, slices);
    setSlice(plane);
    for (ligne = 0; ligne < height; ligne++)
    {
        for (colonne = 0; colonne < width; colonne++)
        {
            valeur = getPixel(colonne, ligne);
            if (valeur == 255)
            {
                x = colonne * pixelWidth;
                y = (height - ligne) * pixelHeight;
                z = plane * pixelWidth;
                str = "" + d2s(x,3) + "," + d2s(y,3) + "," + d2s(z,3);
                File.append(str,nom_fichier);
            }
        }
    }
}
print("fini");
setBatchMode("exit & display");
```

Logiciel utilisé



- logiciel libre de visualisation de données
- fondé sur la bibliothèque VTK
- publié sous licence BSD

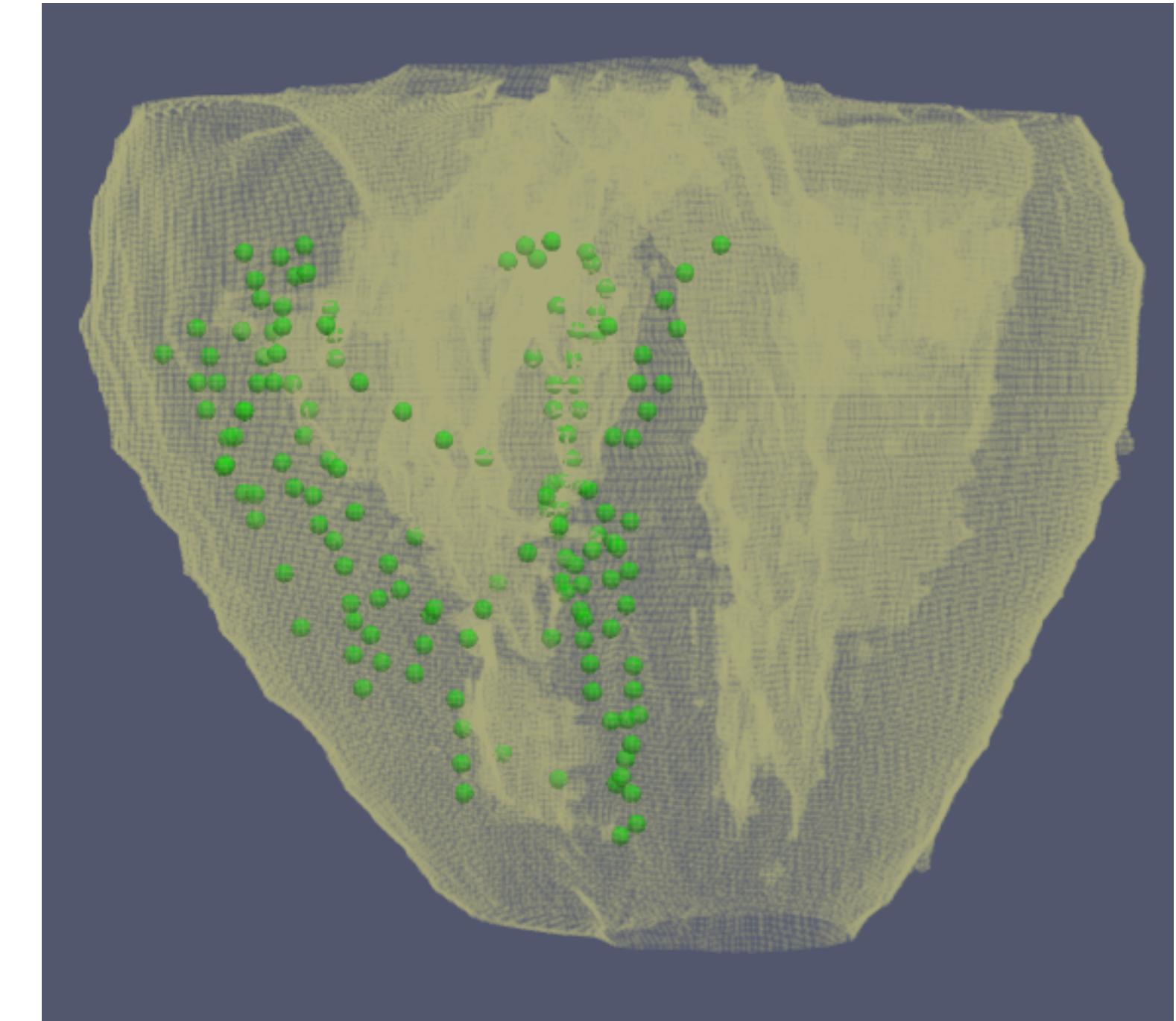
Modéliser l'enveloppe du cœur

Coordonées dans un fichier csv

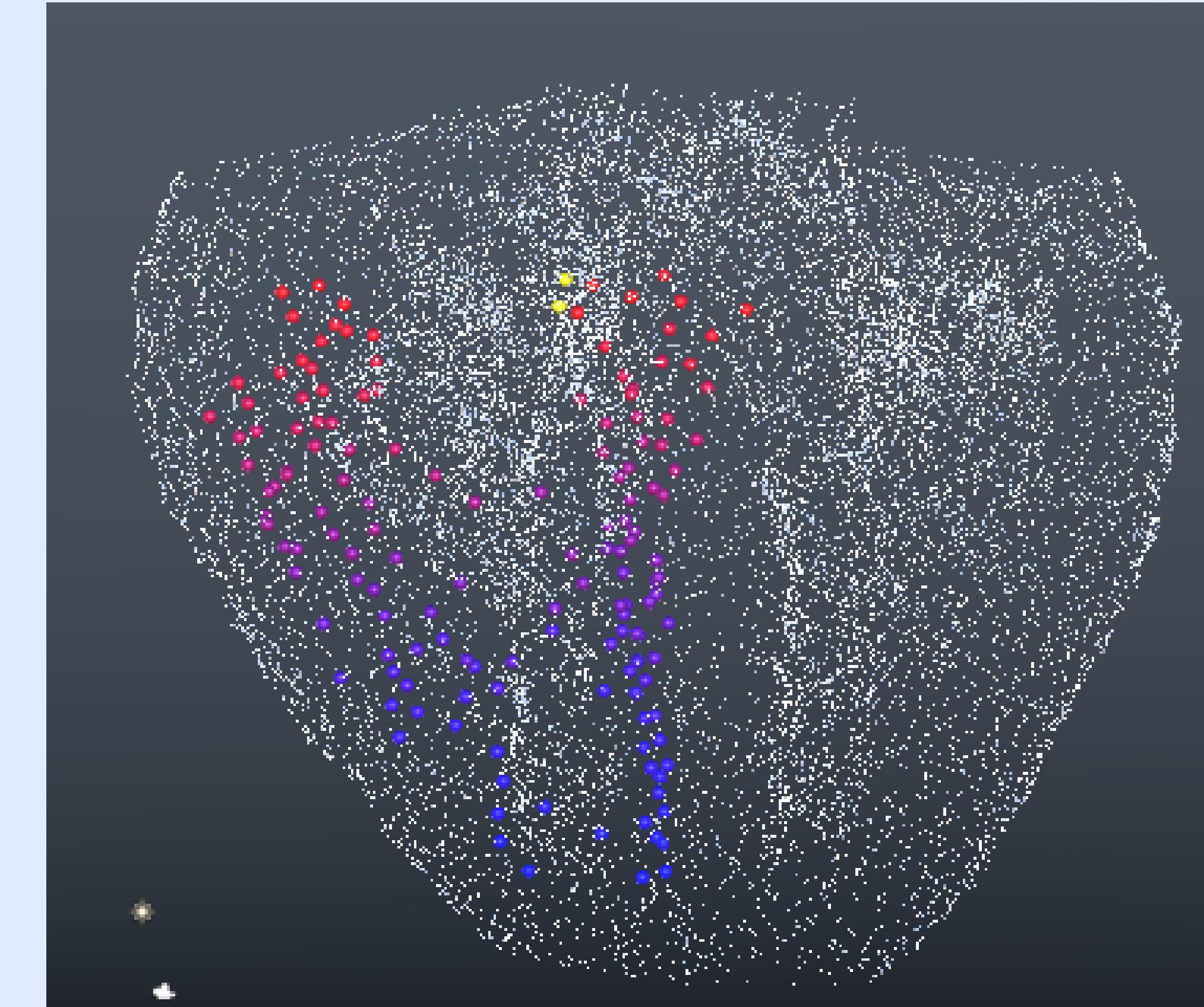
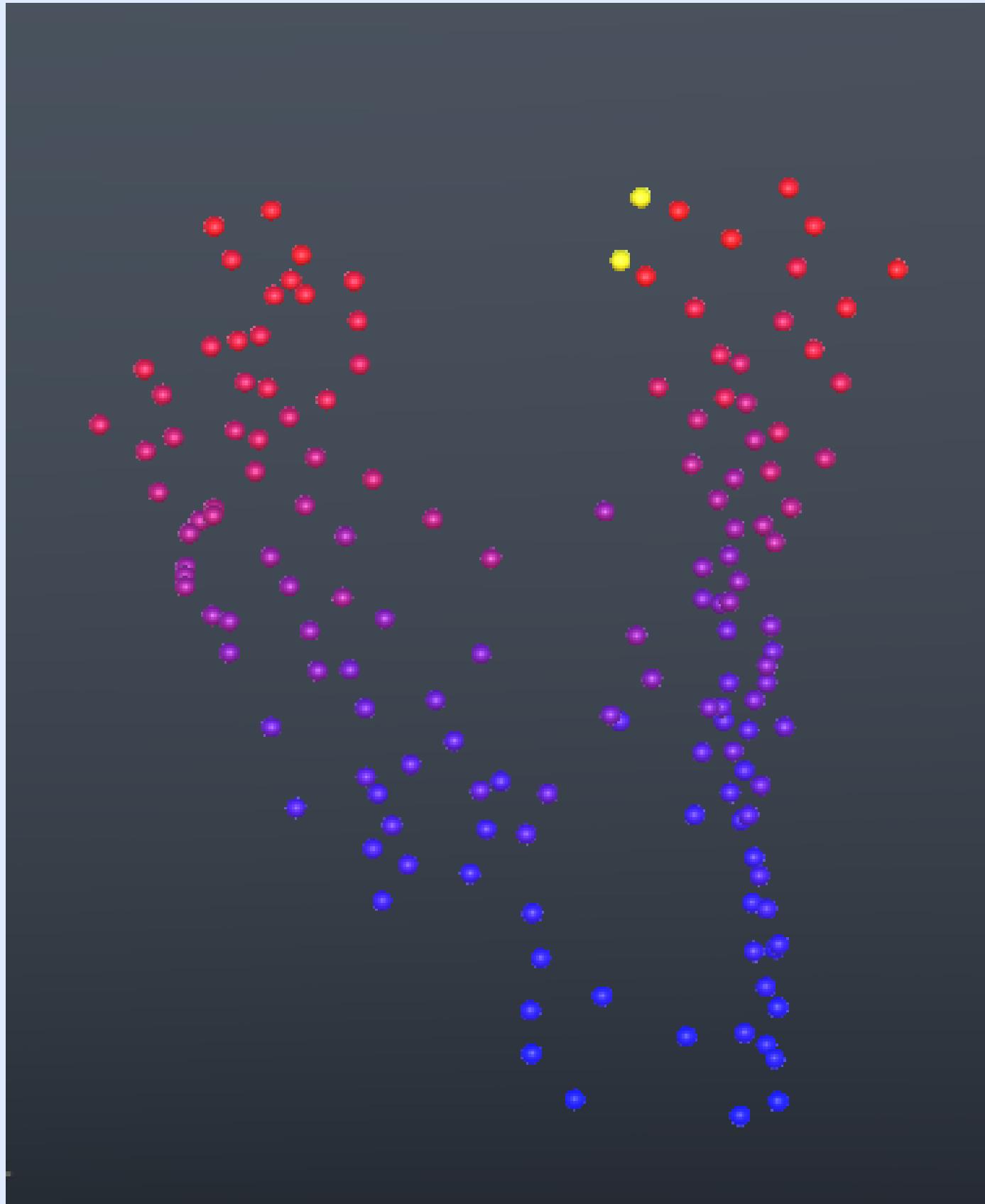
9	23.124	9.118	0.094
10	23.218	9.118	0.094
11	23.312	9.118	0.094
12	21.808	9.024	0.094
13	21.902	9.024	0.094
14	21.996	9.024	0.094
15	22.09	9.024	0.094
16	22.184	9.024	0.094
17	22.278	9.024	0.094
18	22.372	9.024	0.094
19	23.312	9.024	0.094
20	23.406	9.024	0.094
21	23.5	9.024	0.094
22	23.594	9.024	0.094
23	23.688	9.024	0.094
24	23.782	9.024	0.094
25	23.876	9.024	0.094



Modélisation en nuage de points



Nuages de points sur Unity3D

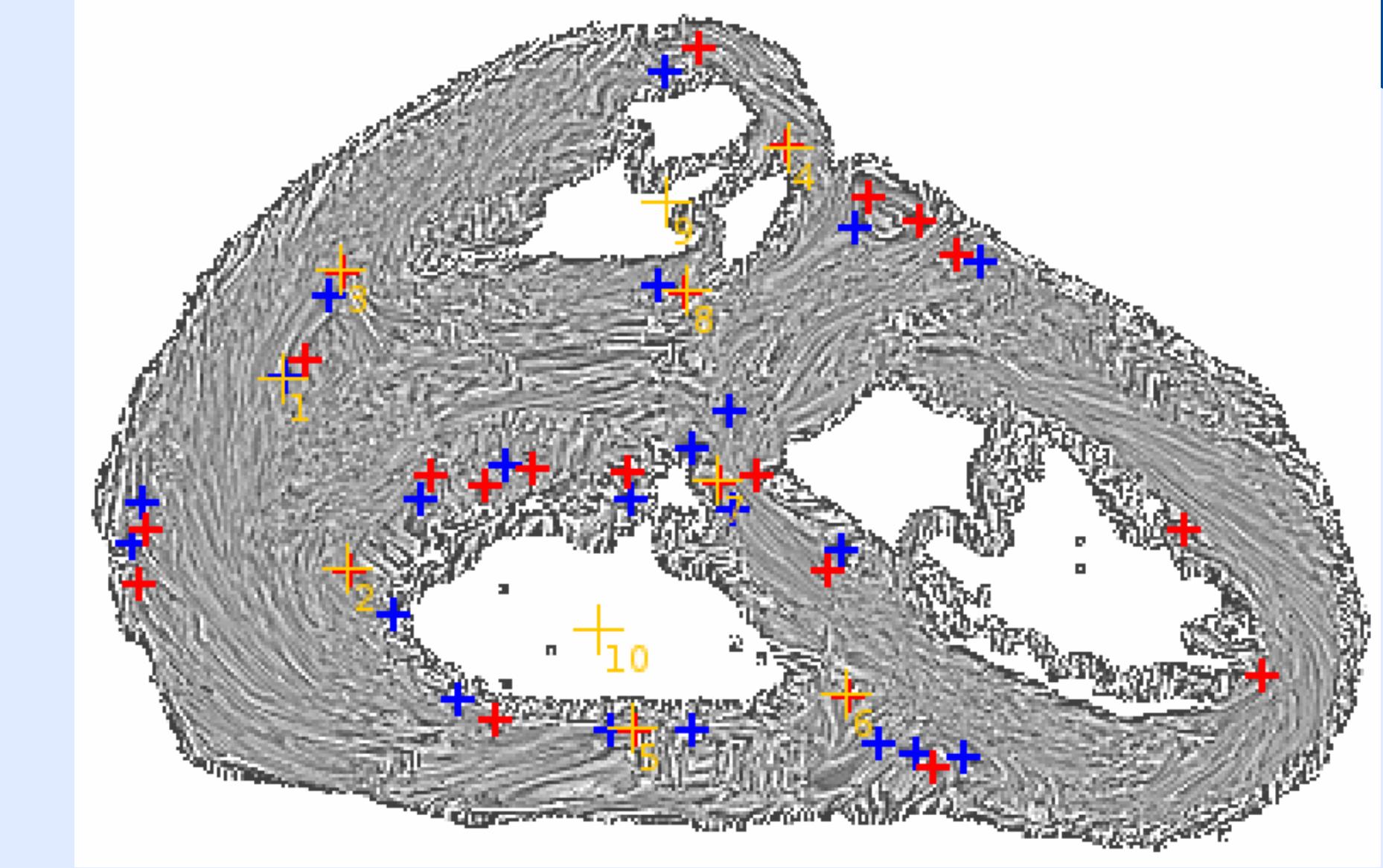
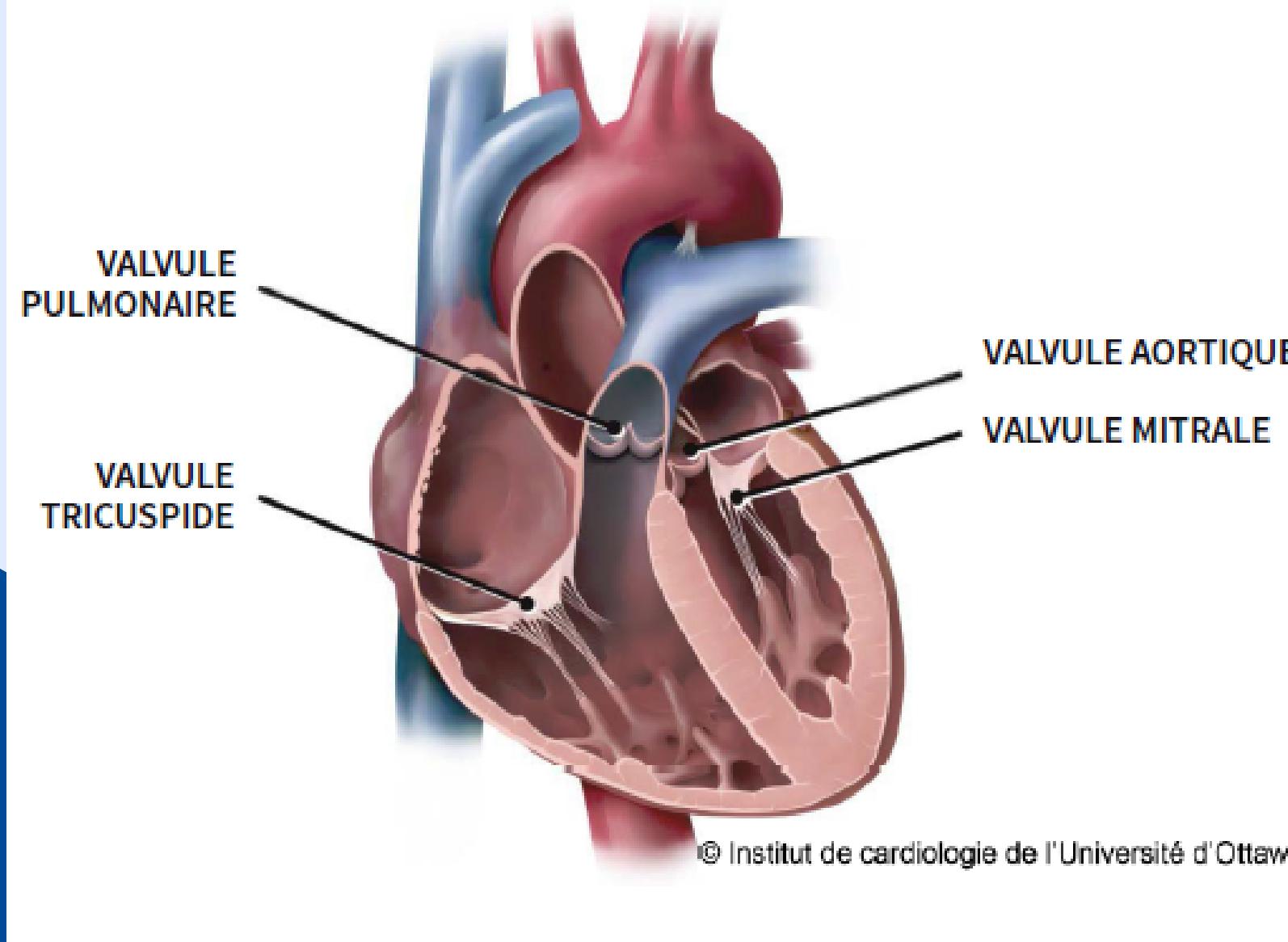


Logiciel utilisé



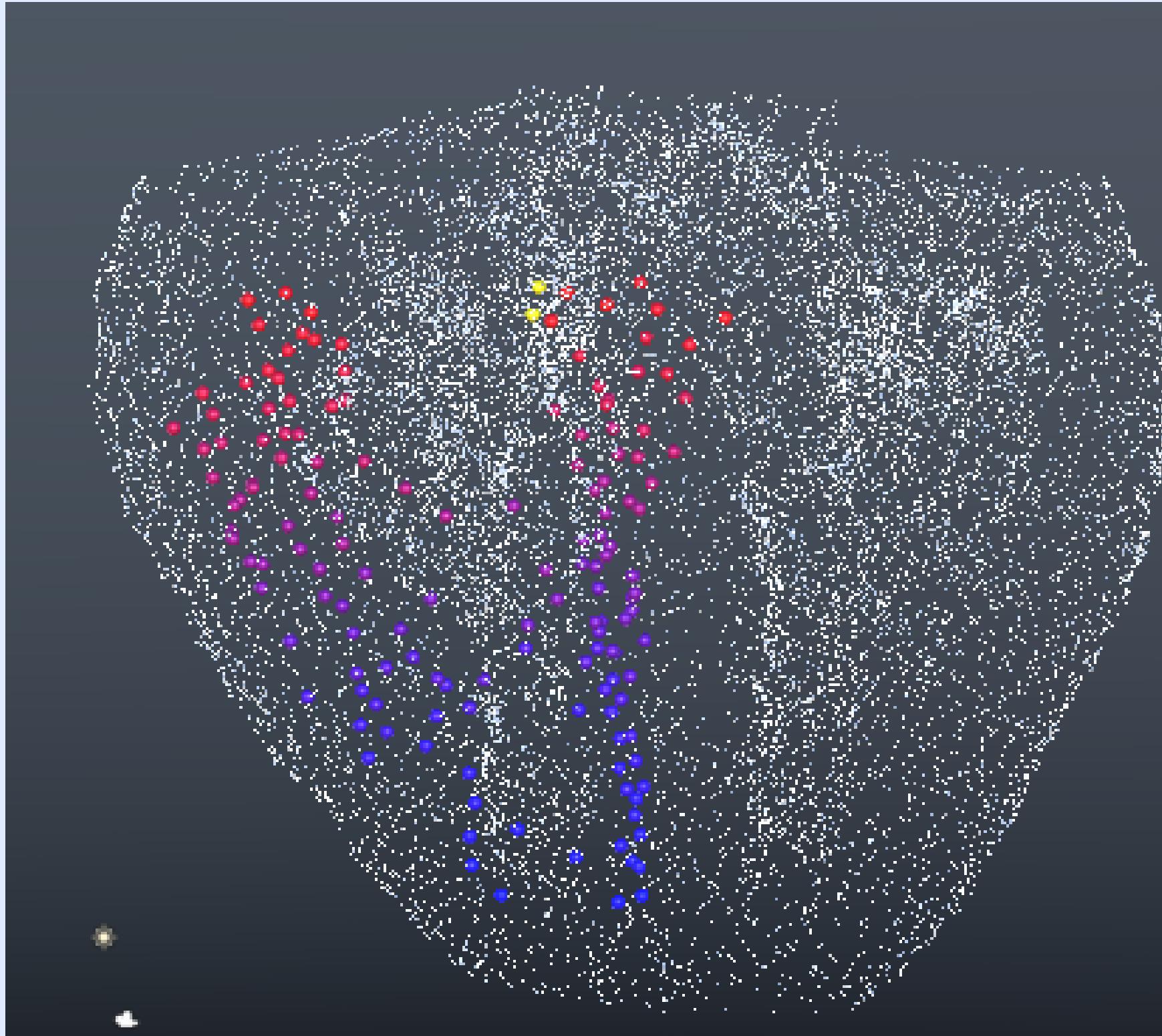
- Moteur de jeu multiplateforme développé par Unity Technologies
- Licence gratuite « Personal » avec quelques limitations de technologie
- C#, C++

Nuage de points

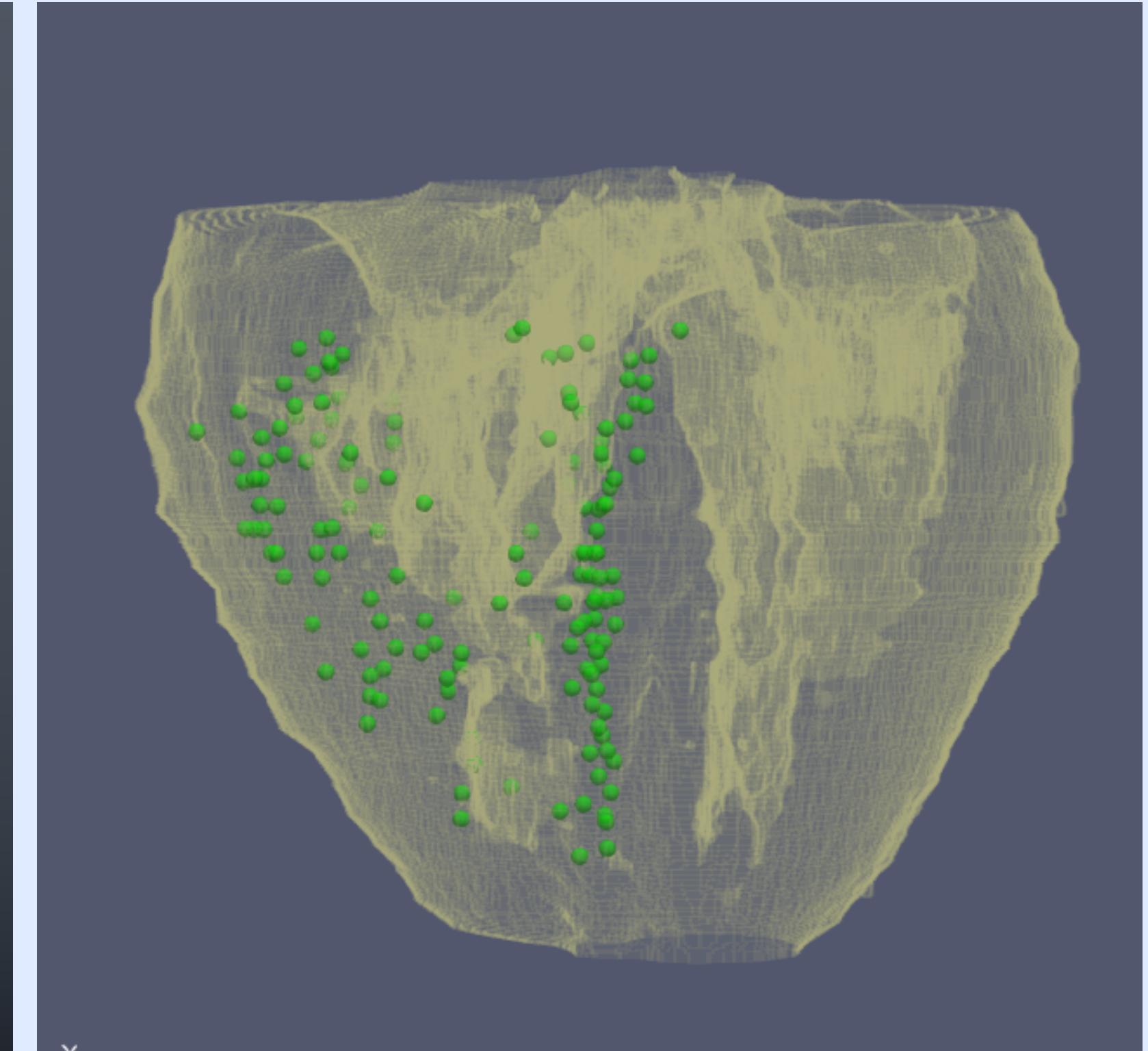


Nuage de points

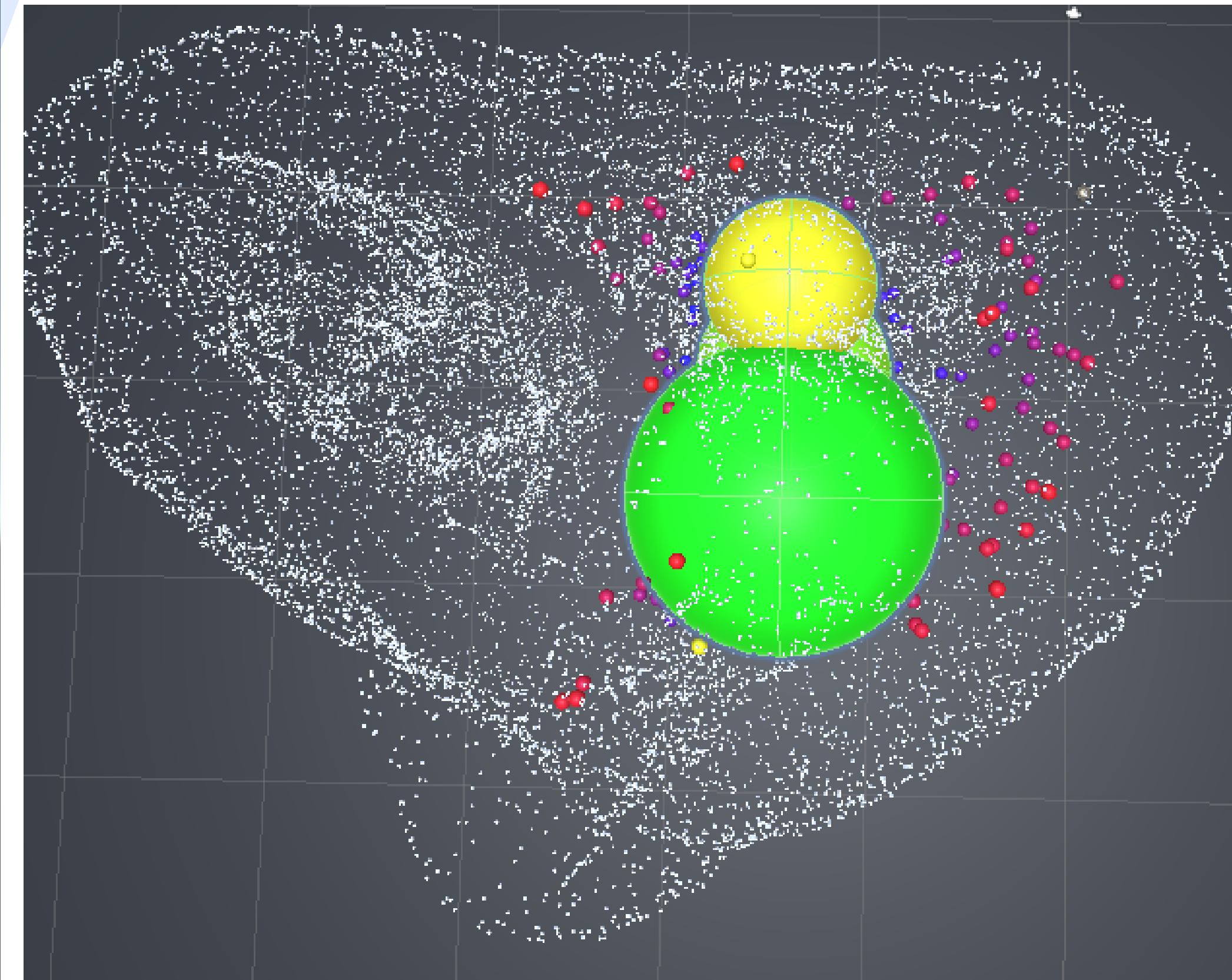
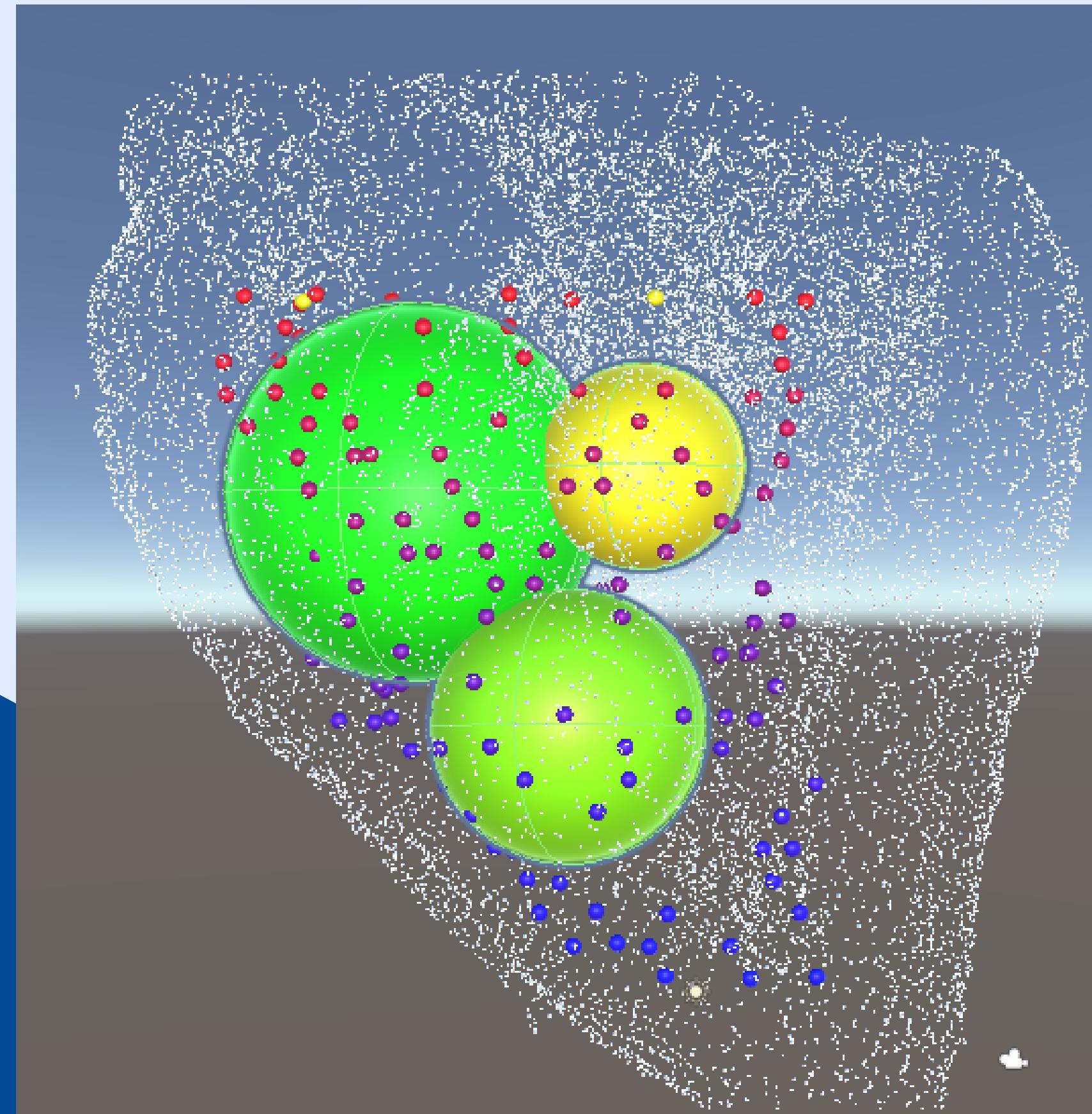
Unity3D



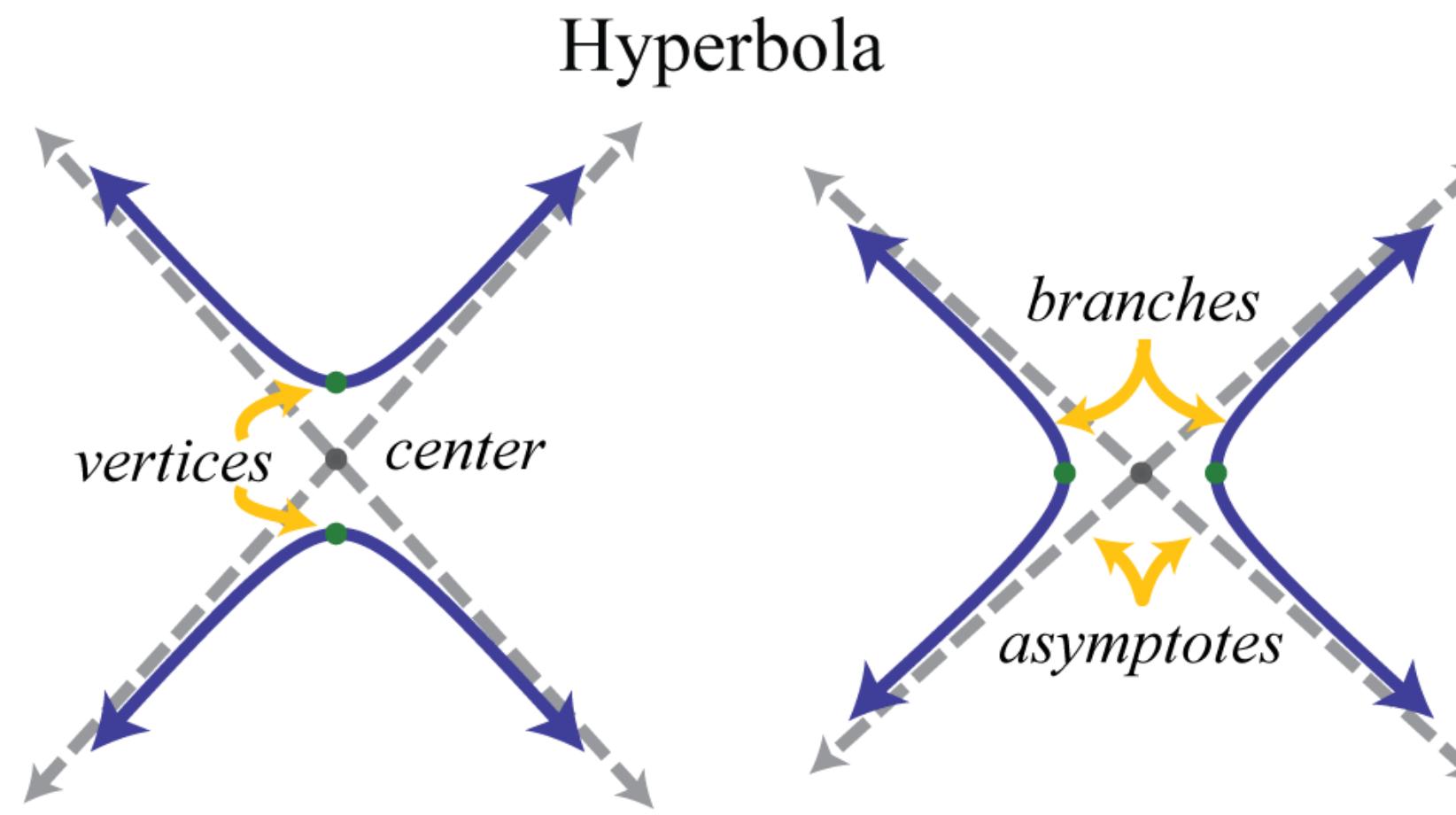
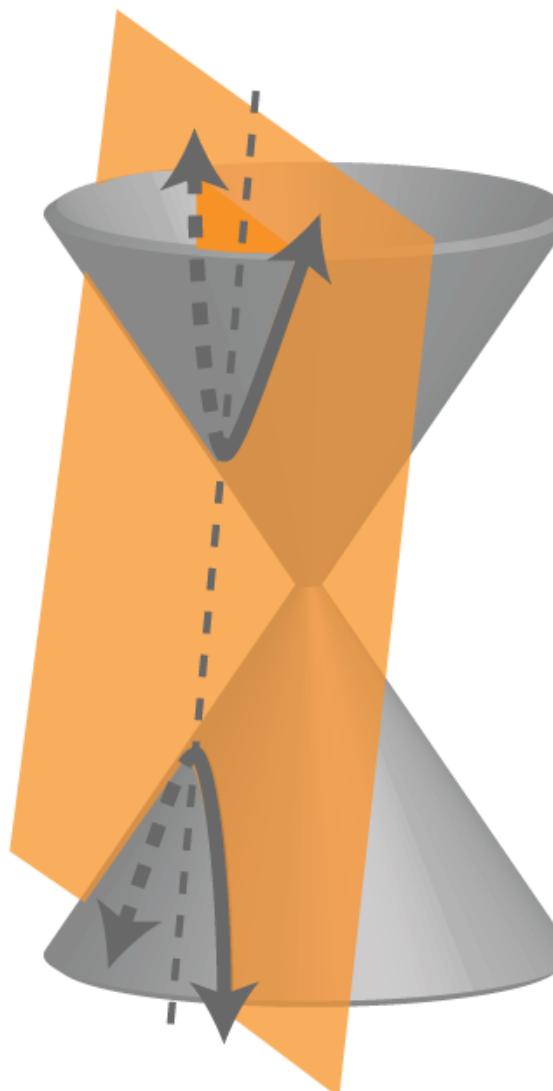
ParaView



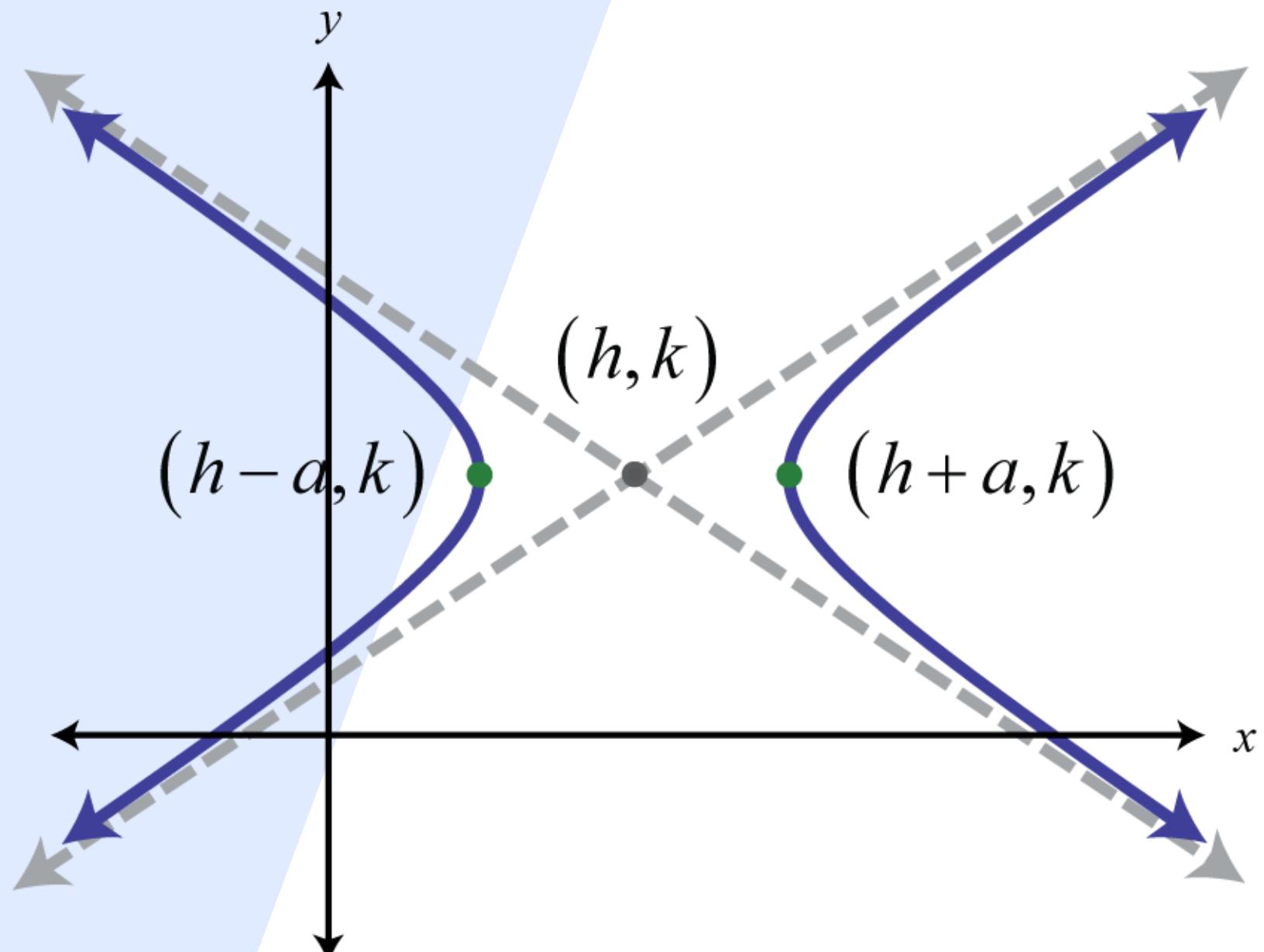
Placement des sphères



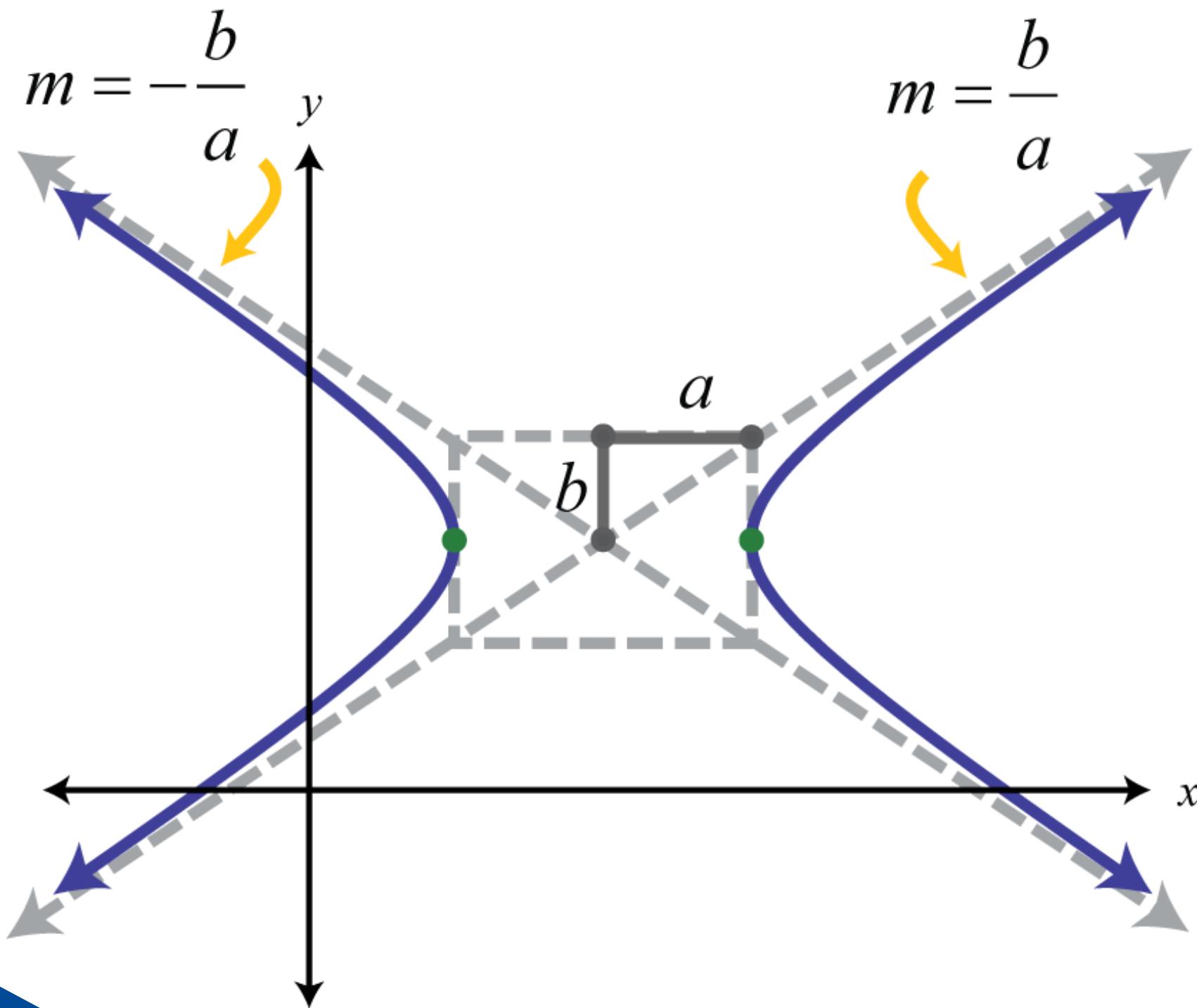
Hyperbole



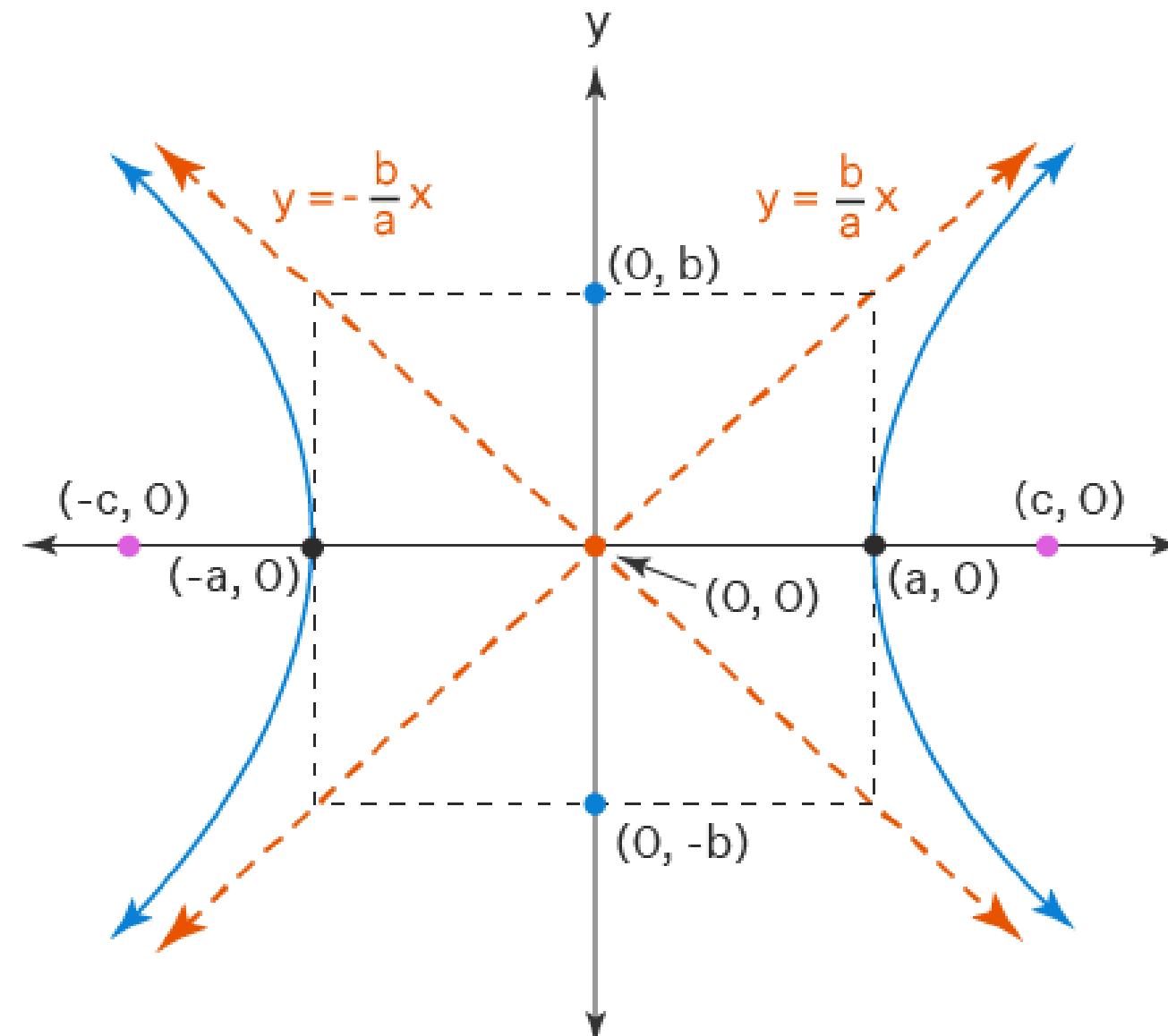
Hyperbole



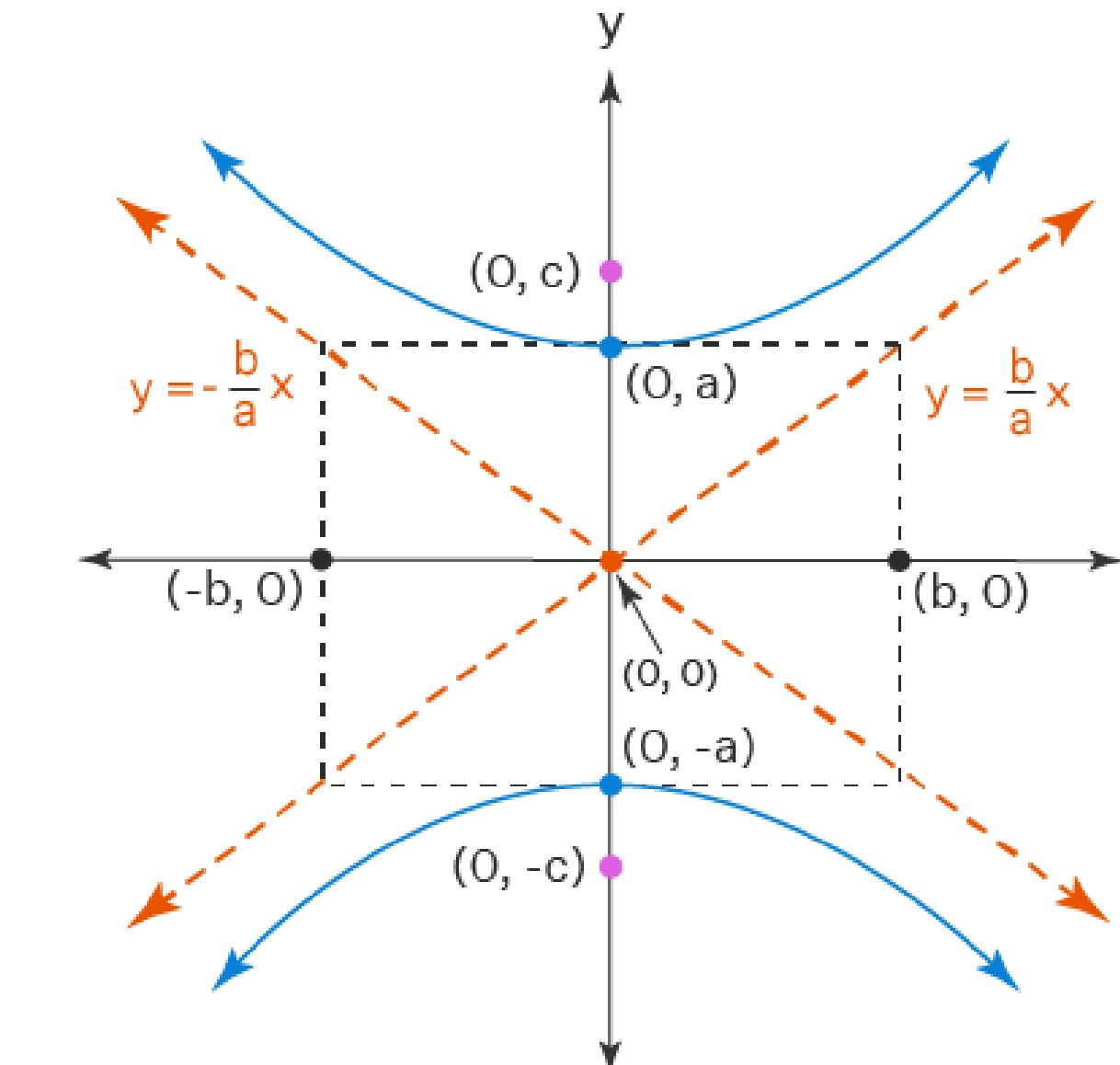
Hyperbole



Équation de l'hyperbole



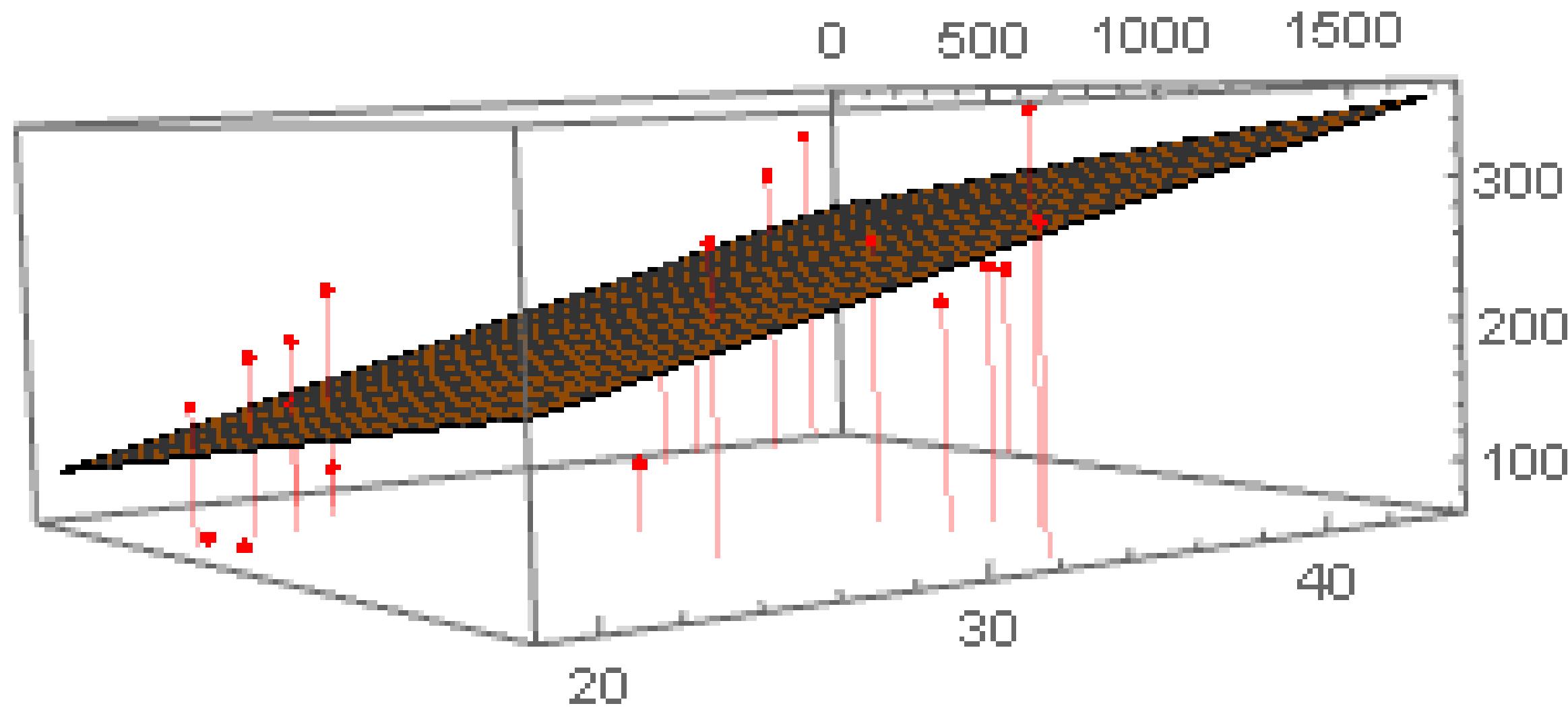
$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$



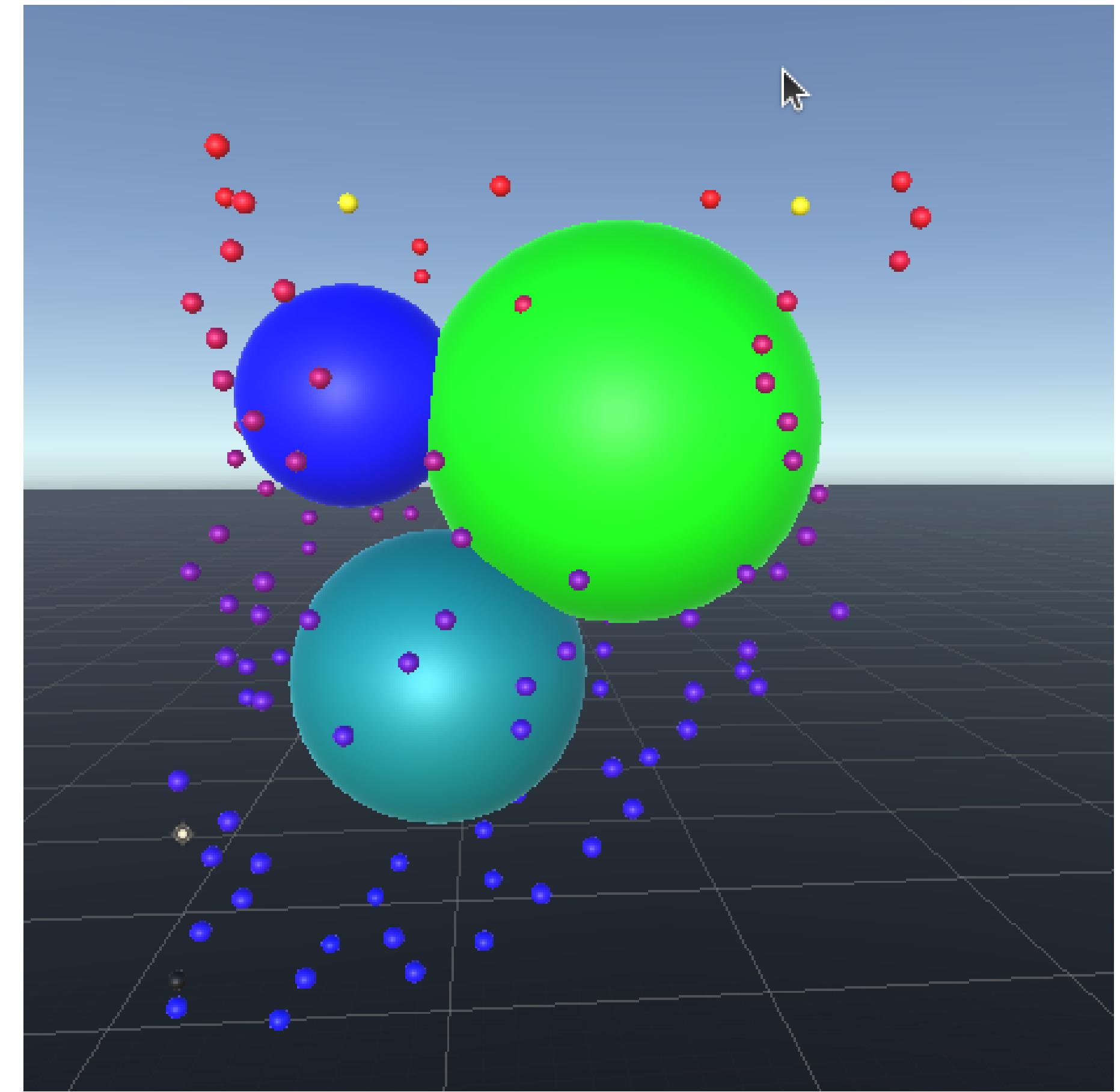
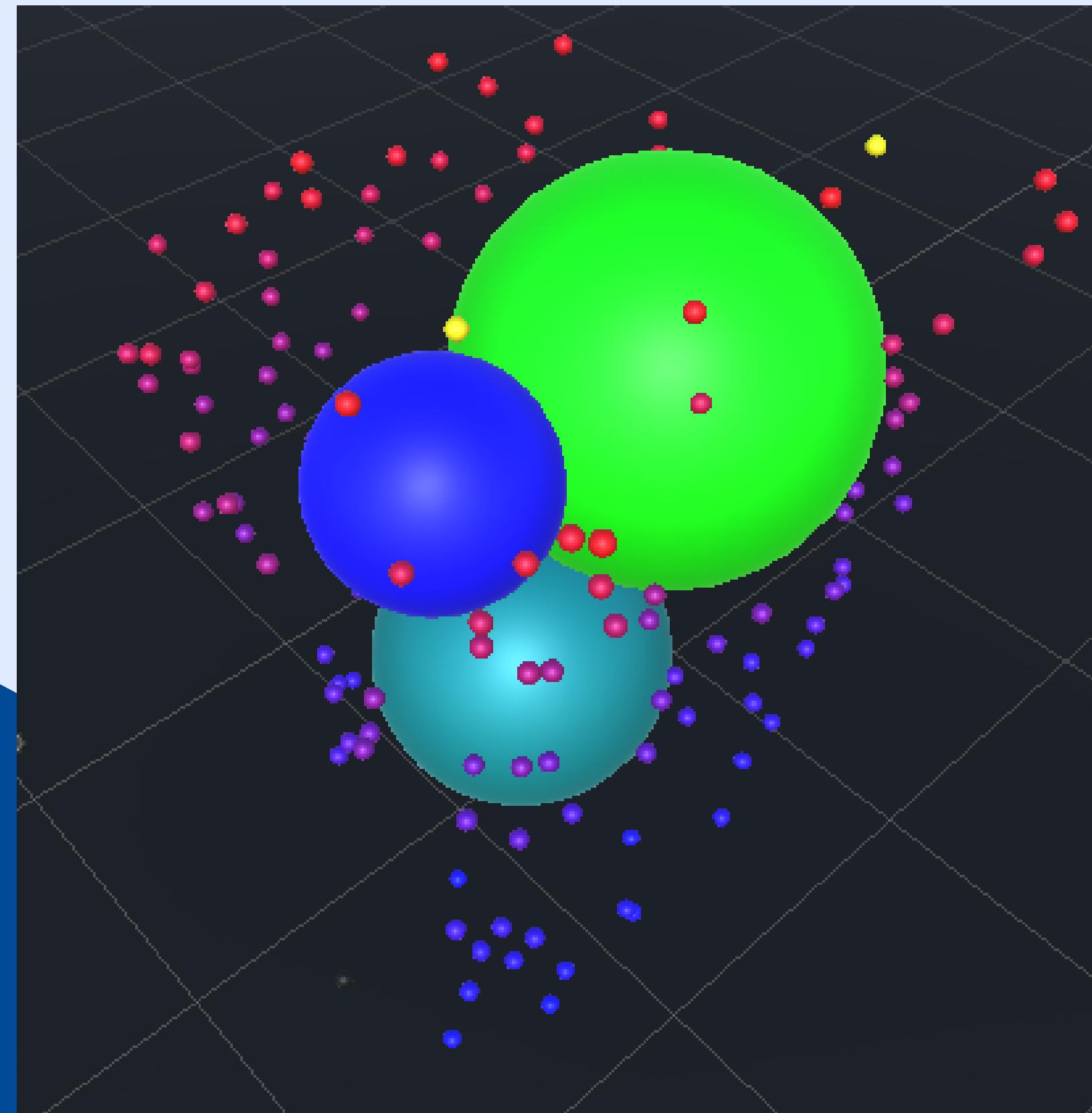
$$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$$

Calcul du plan

Méthode des moindres carrés :



Calcul du plan



Calcul du plan

Méthode des moindres carrés :

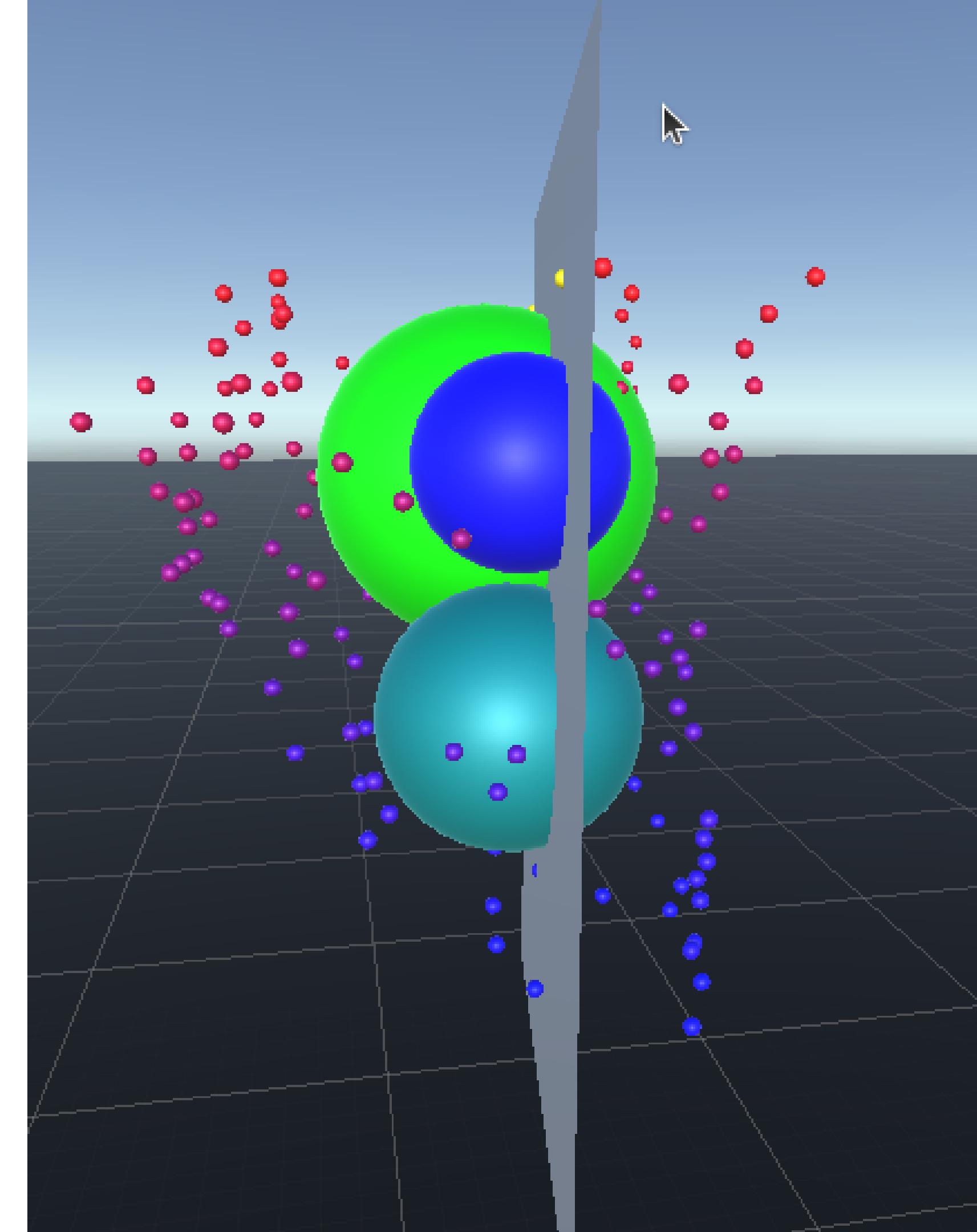
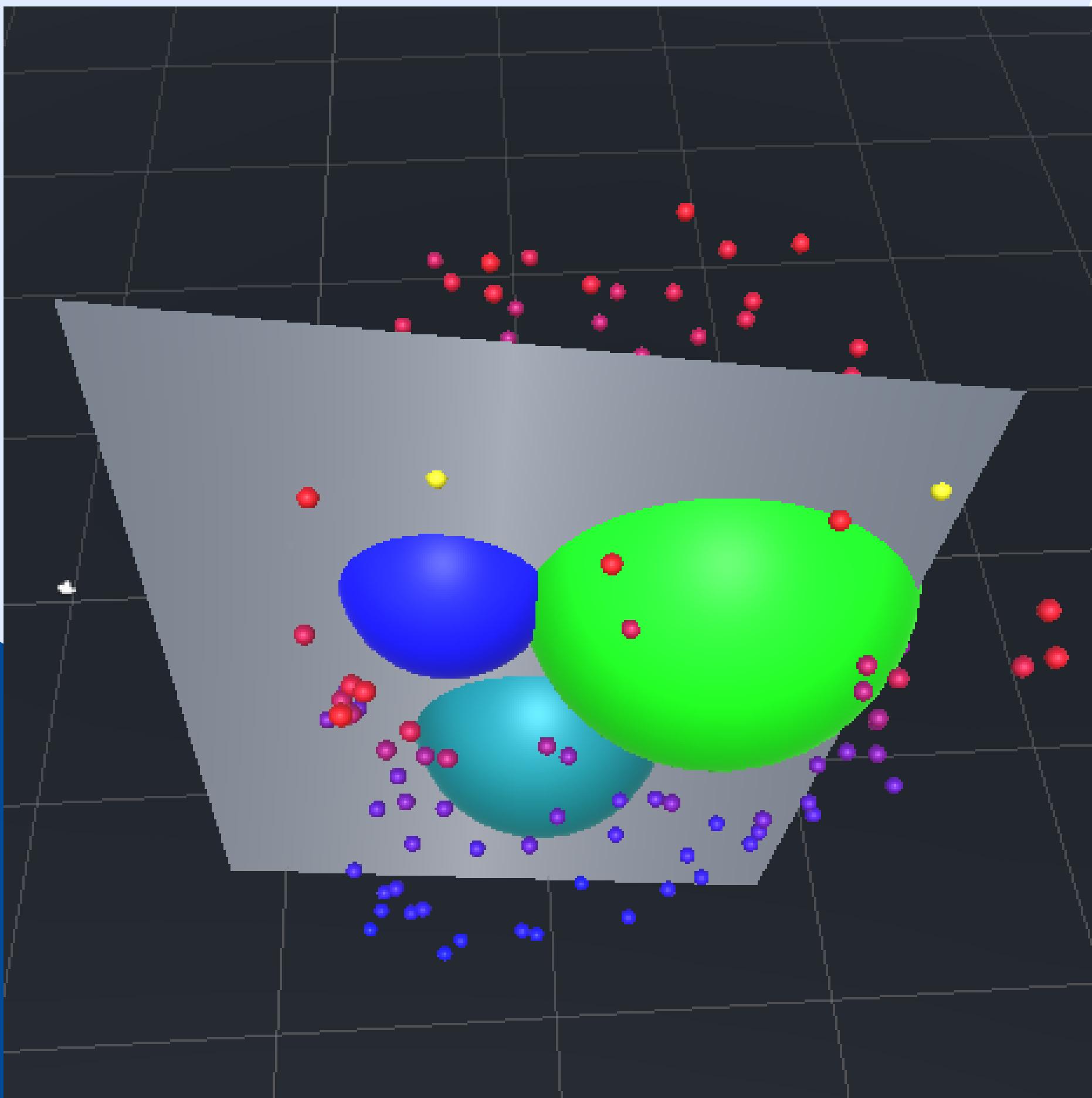
```
Vector3 calcul_moindres_carres(params Vector3[] points) {
    // Calculer le centre de masse (centroid) des points
    Vector3 centroid = Vector3.zero;

    // Additionner toutes les positions des points
    foreach (Vector3 point in points) {
        centroid += point;
    }

    // Diviser la somme par le nombre de points pour obtenir le centre de masse
    centroid /= points.Length;

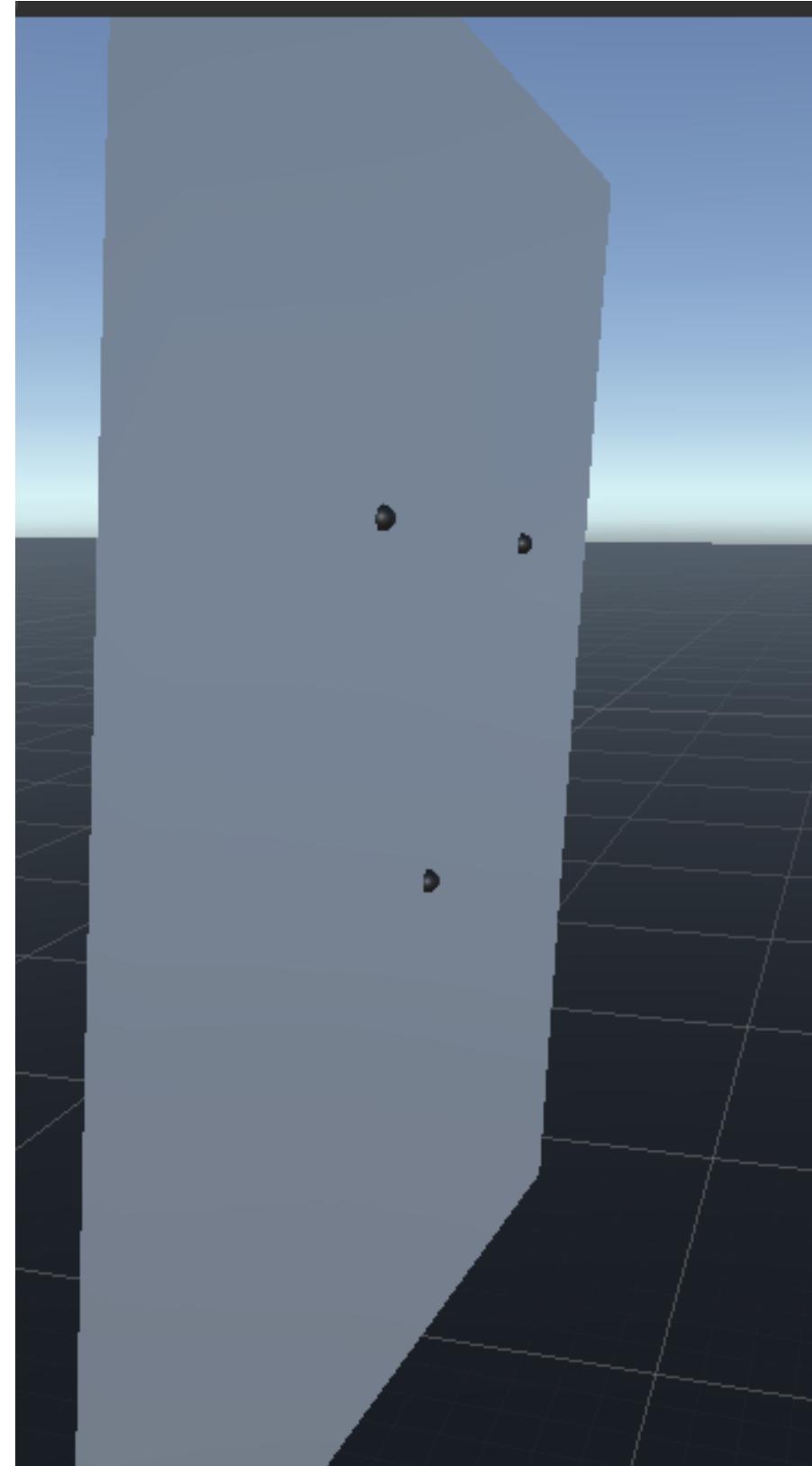
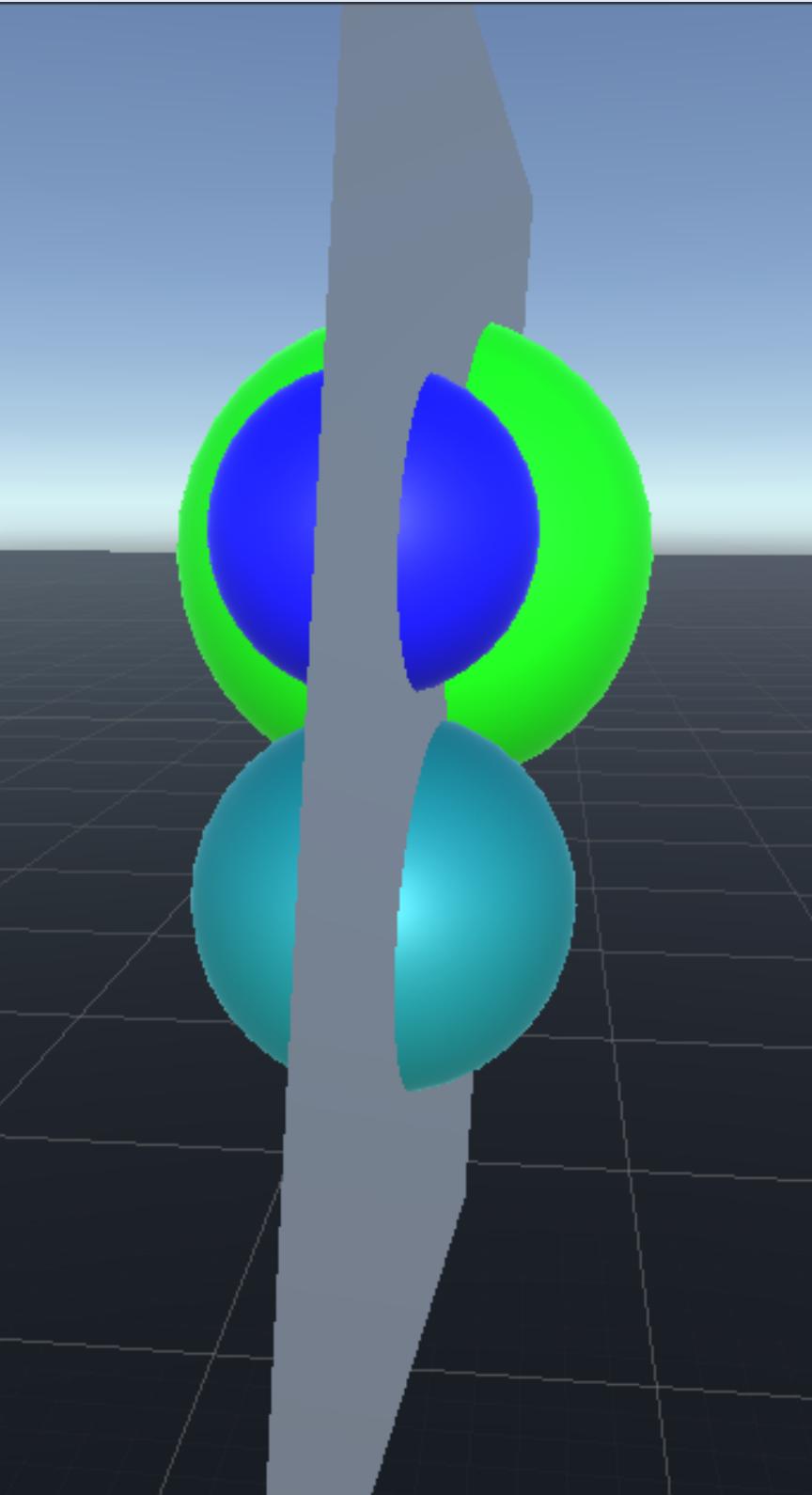
    // Retourner le "point des moindres carrés"
    return centroid;
}
```

Calcul du plan

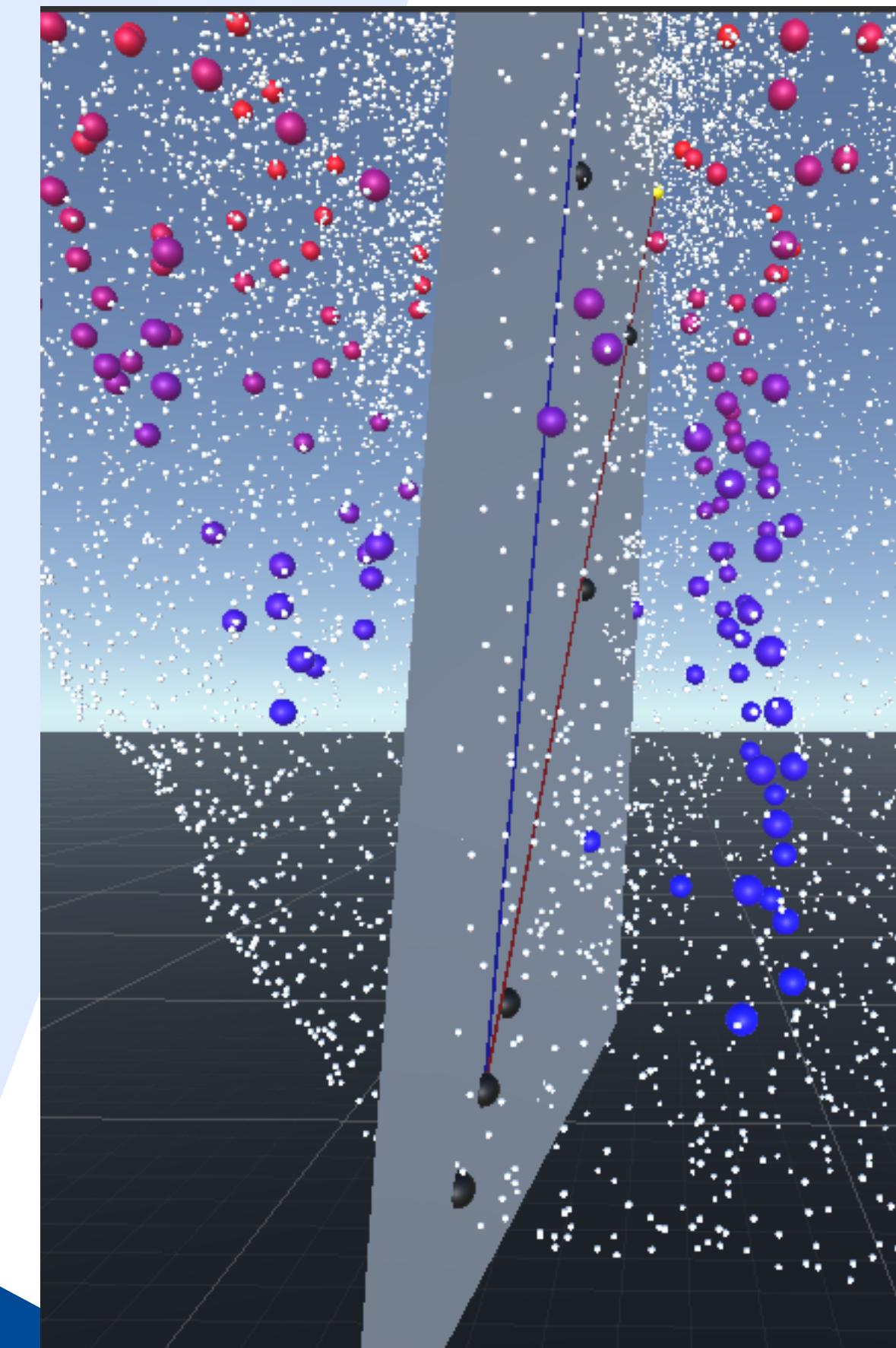


Projection des centres

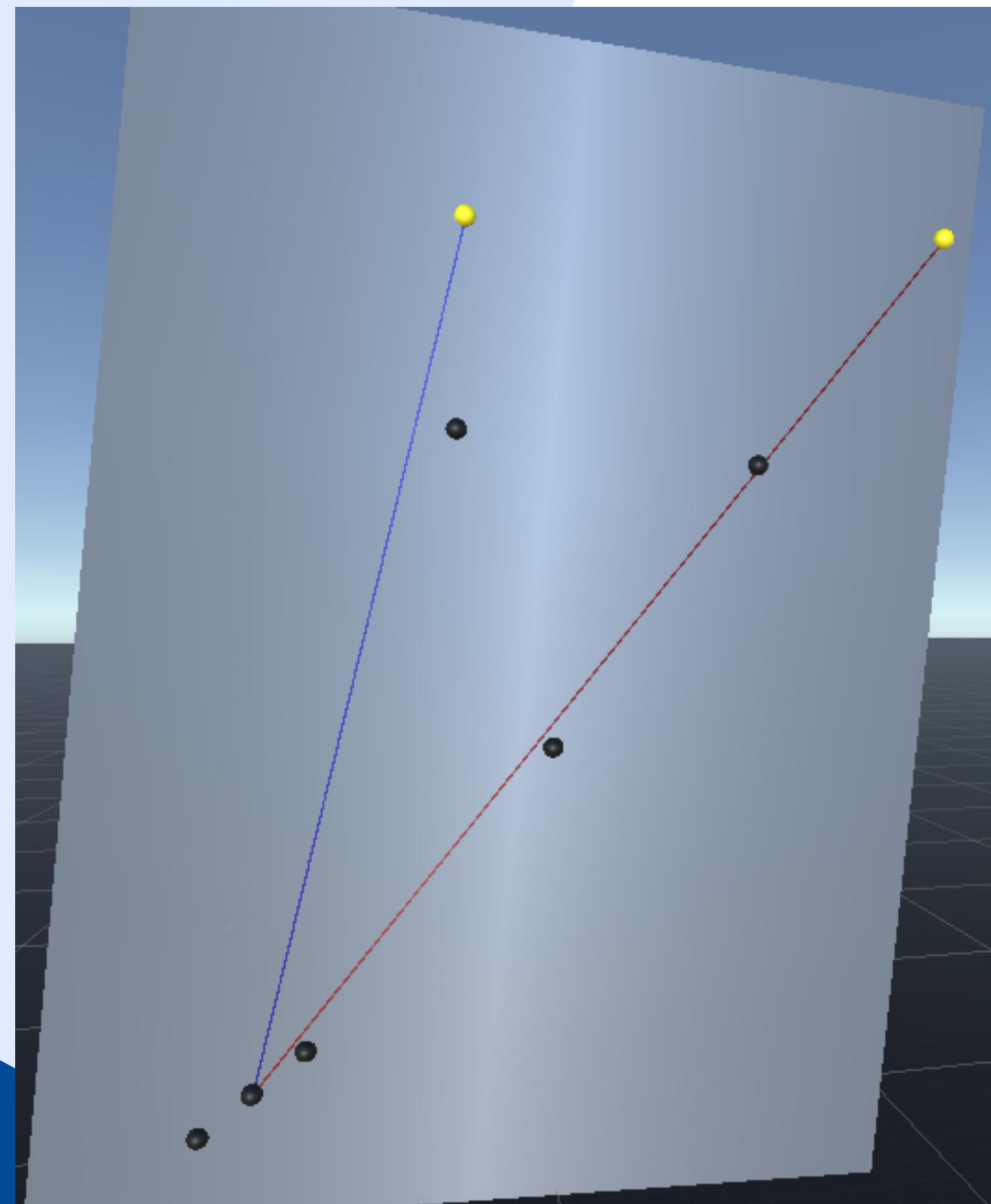
Pour tracer les asymptotes à l'hyperbole



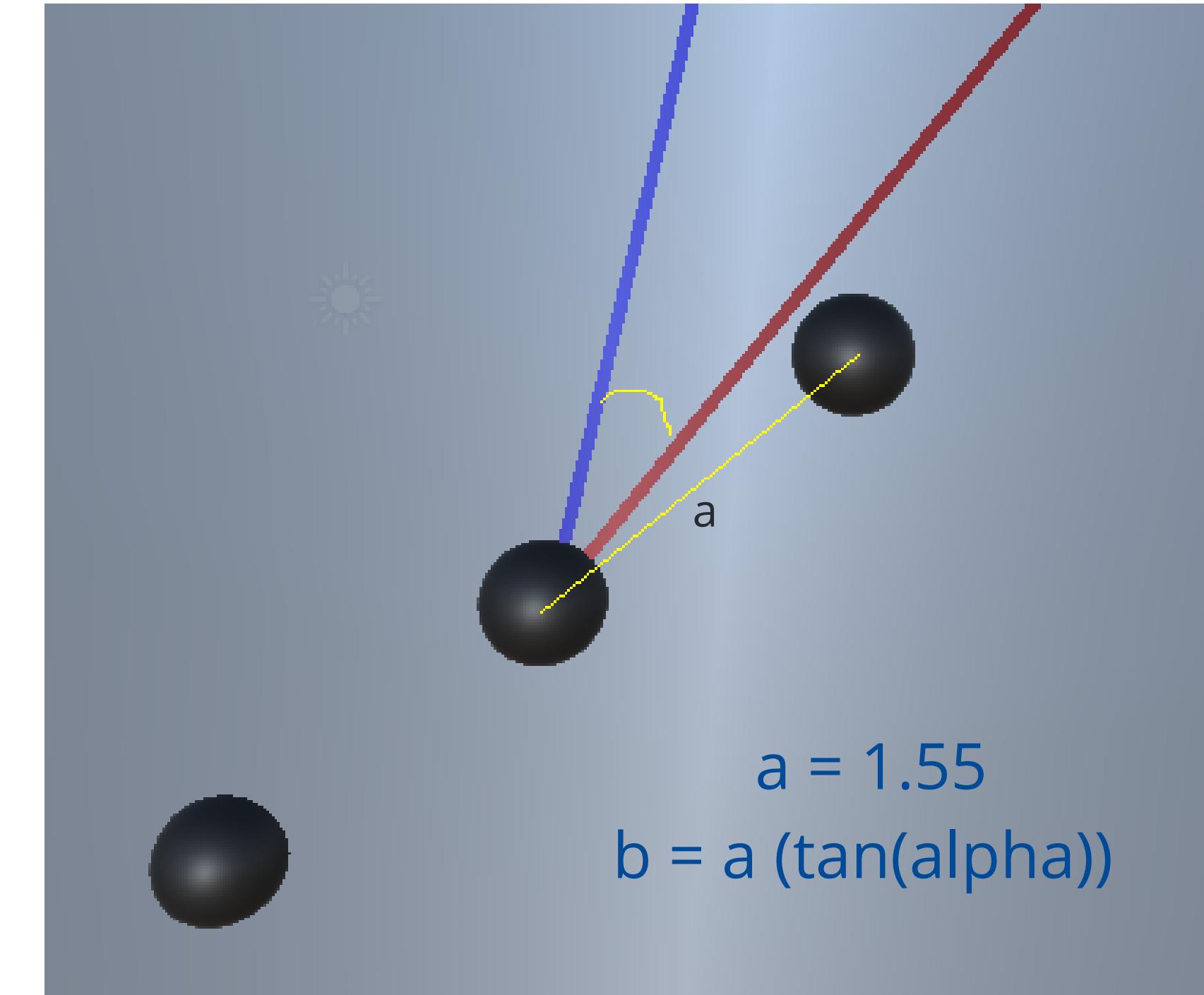
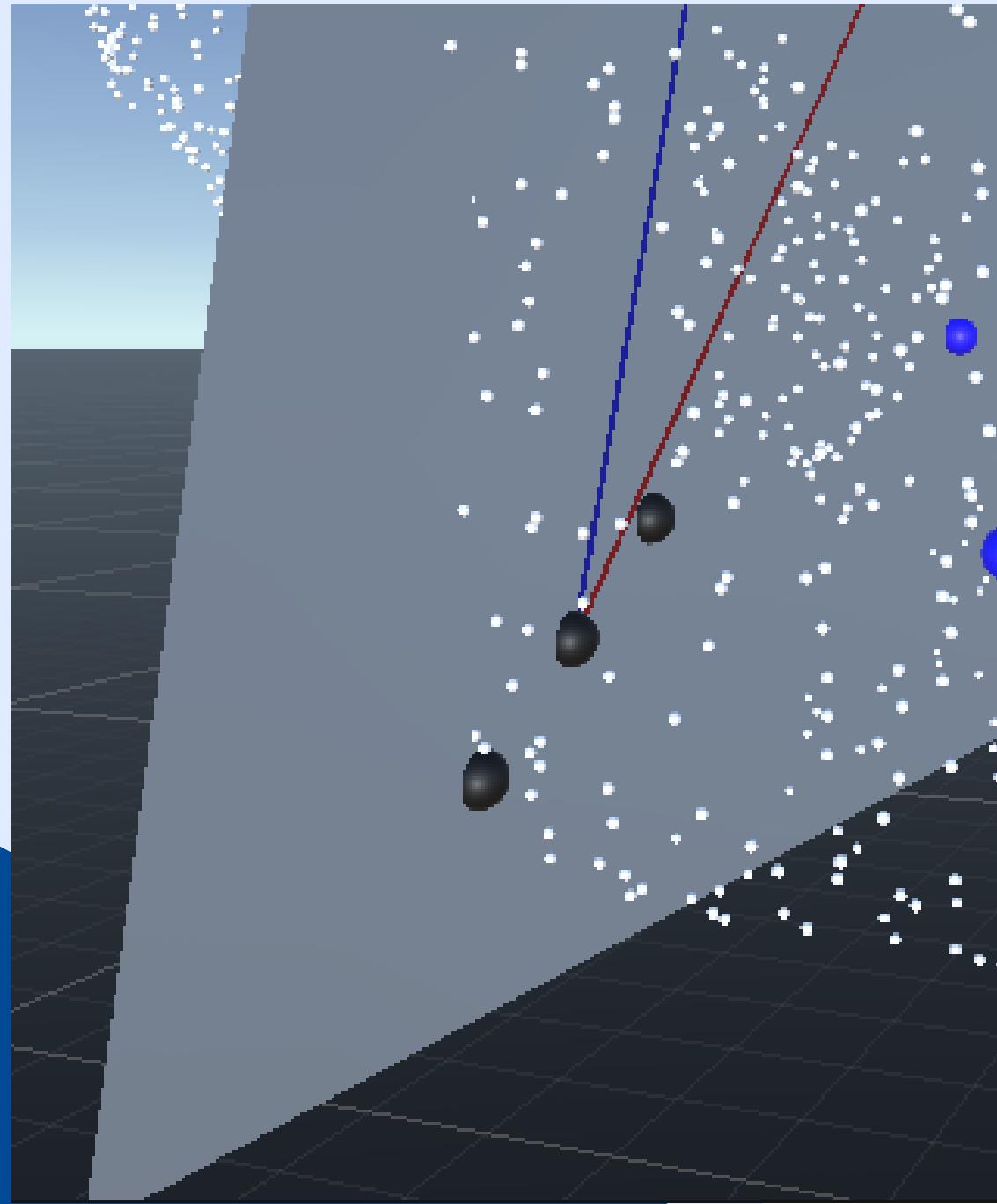
Déterminer le centre de l'hyperbole



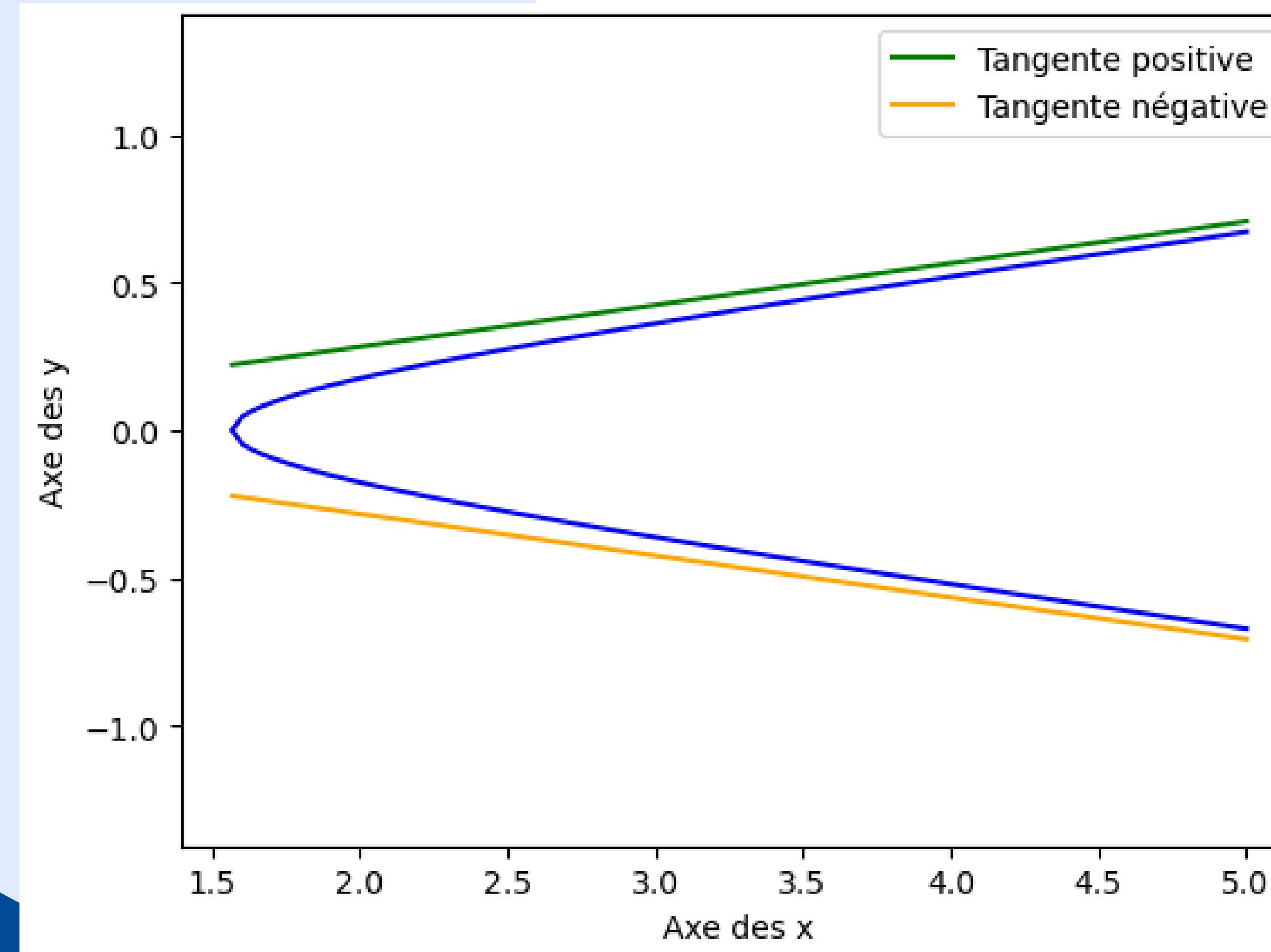
Tracer les asymptotes



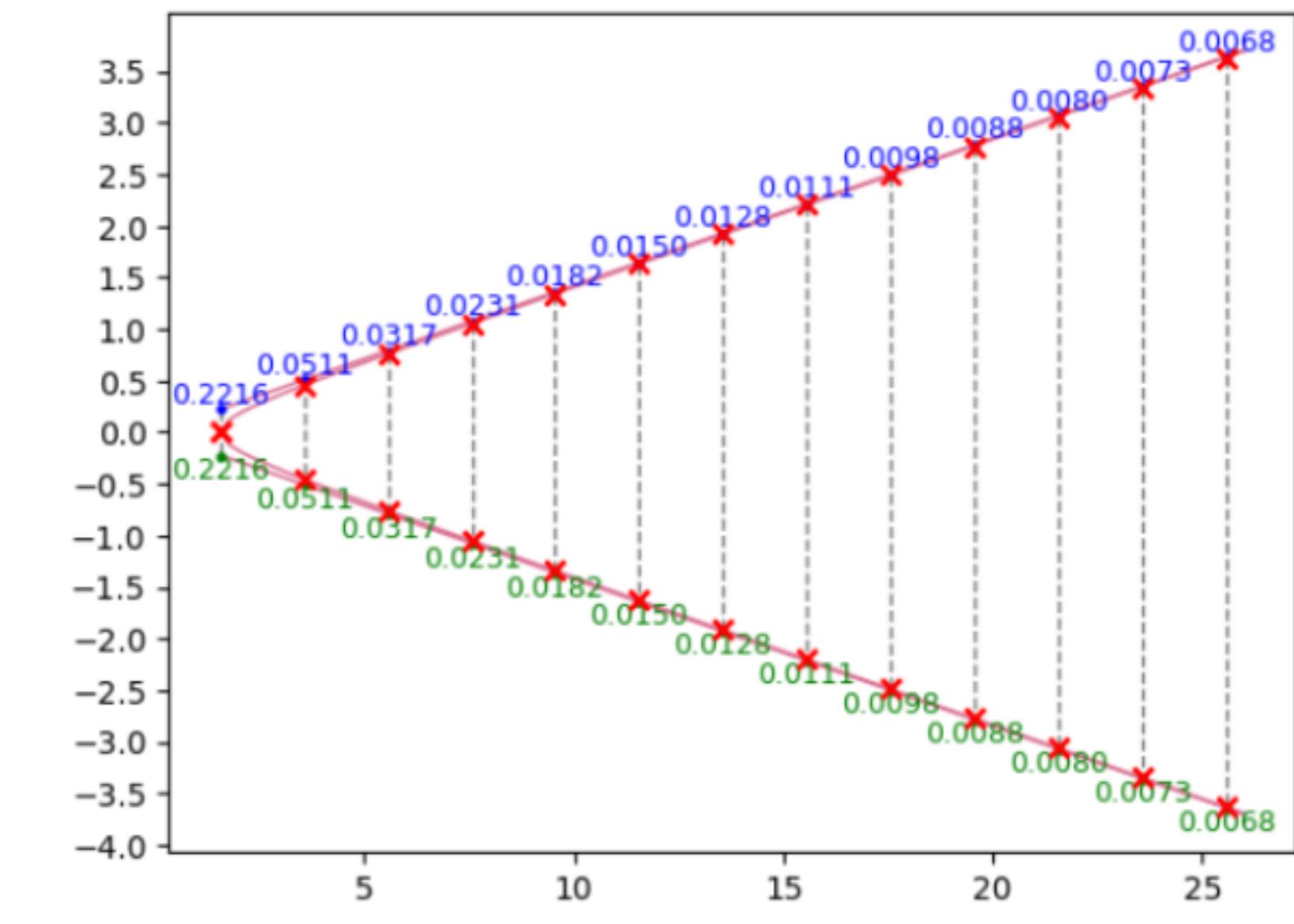
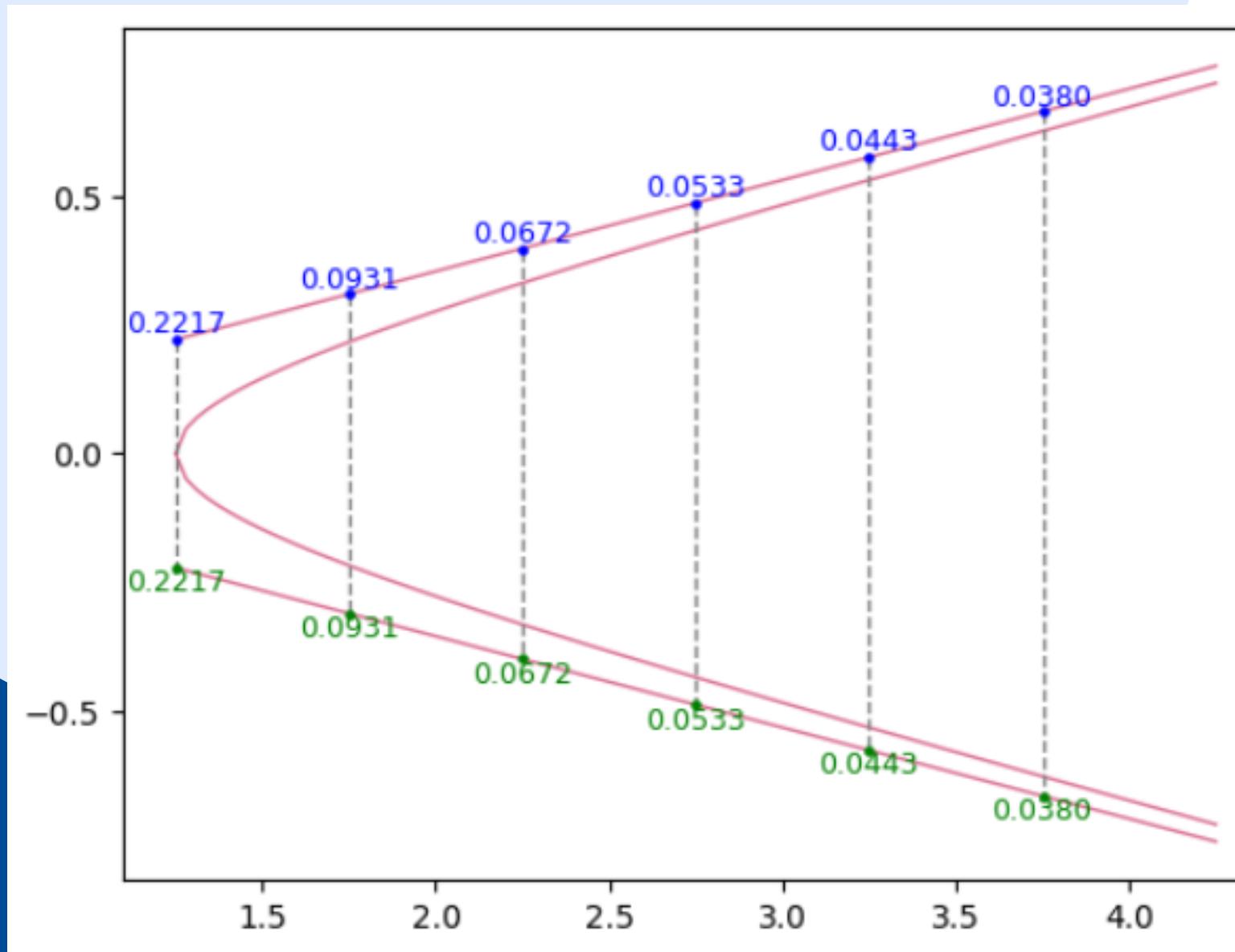
Calcul des paramètres de l'hyperbole



Matplotlib

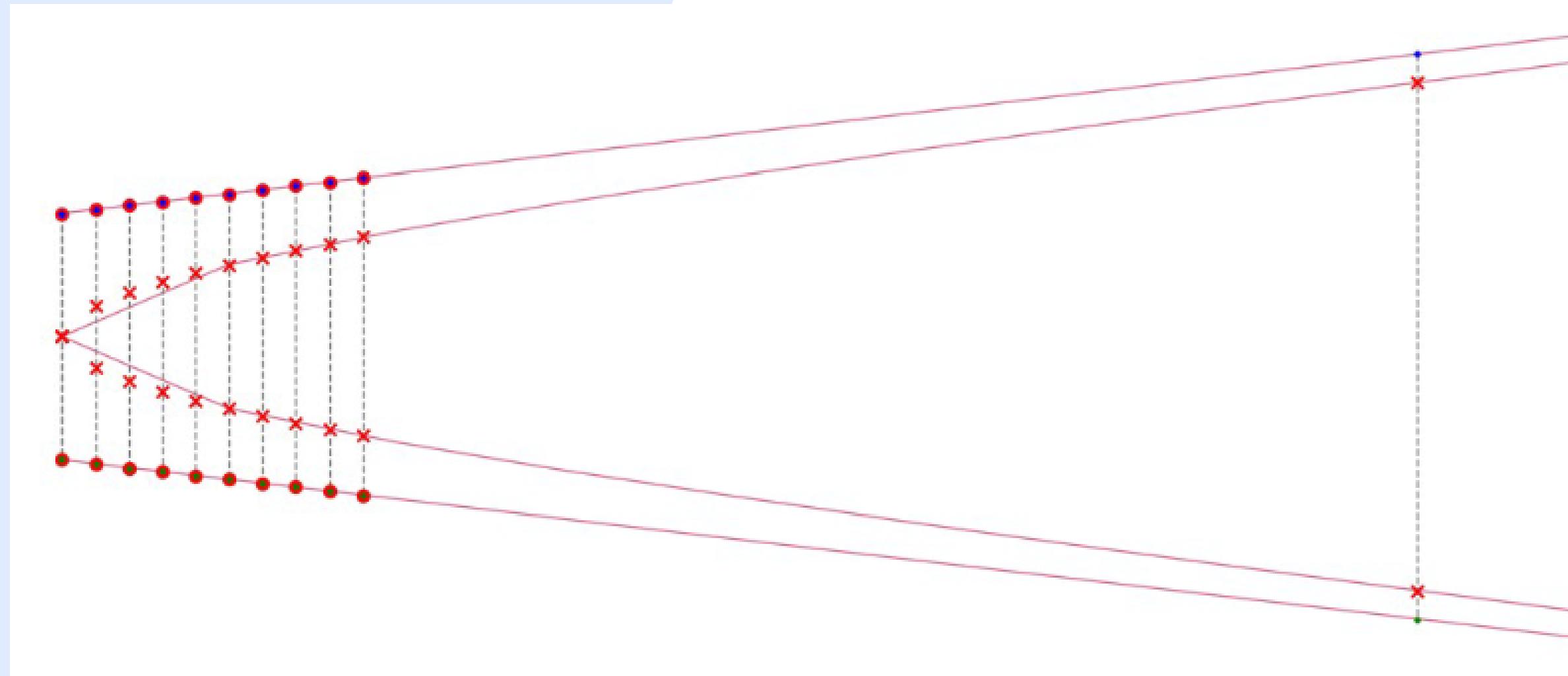


Matplotlib

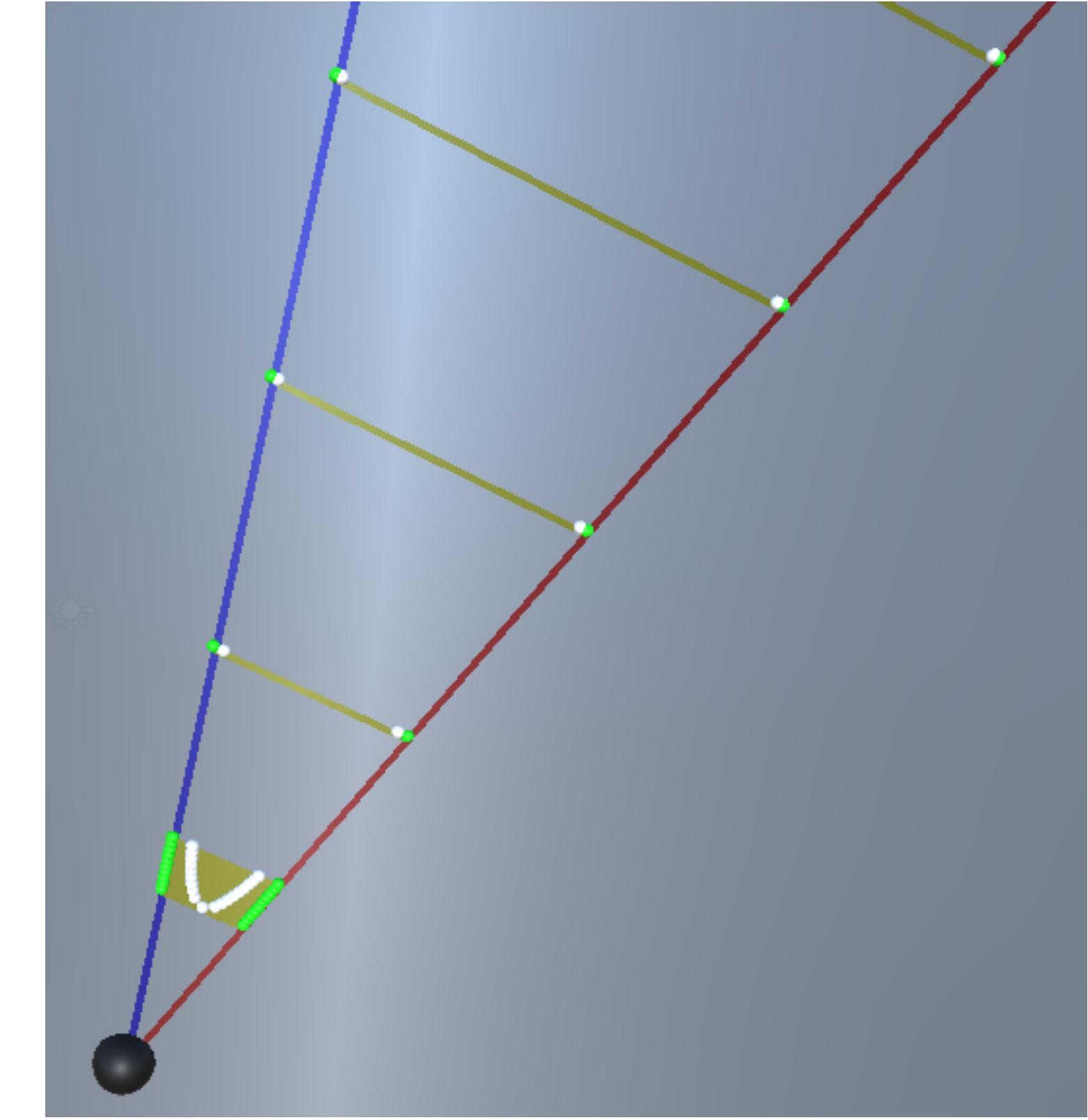
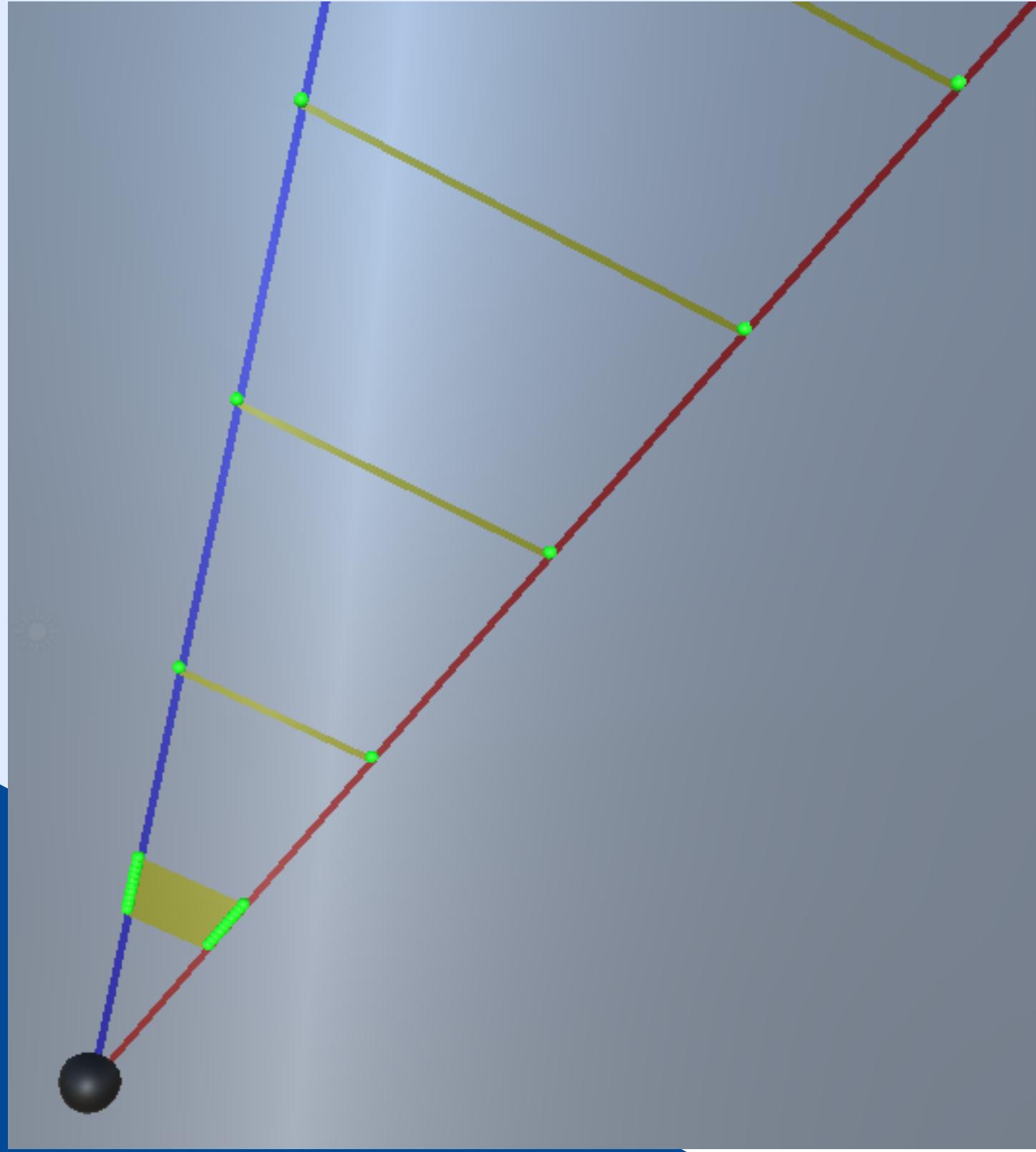


Matplotlib

Échantillonnage serré :

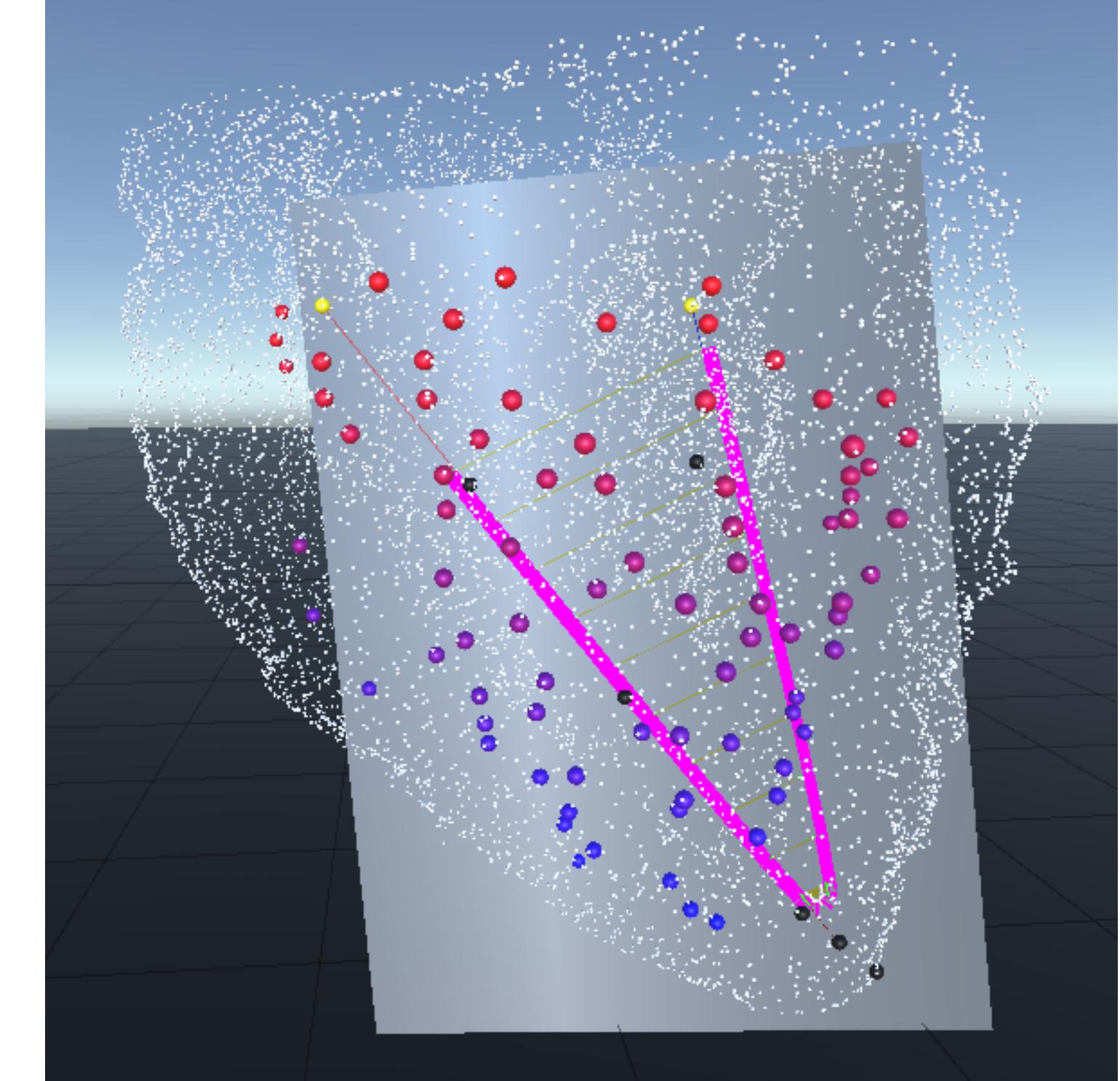
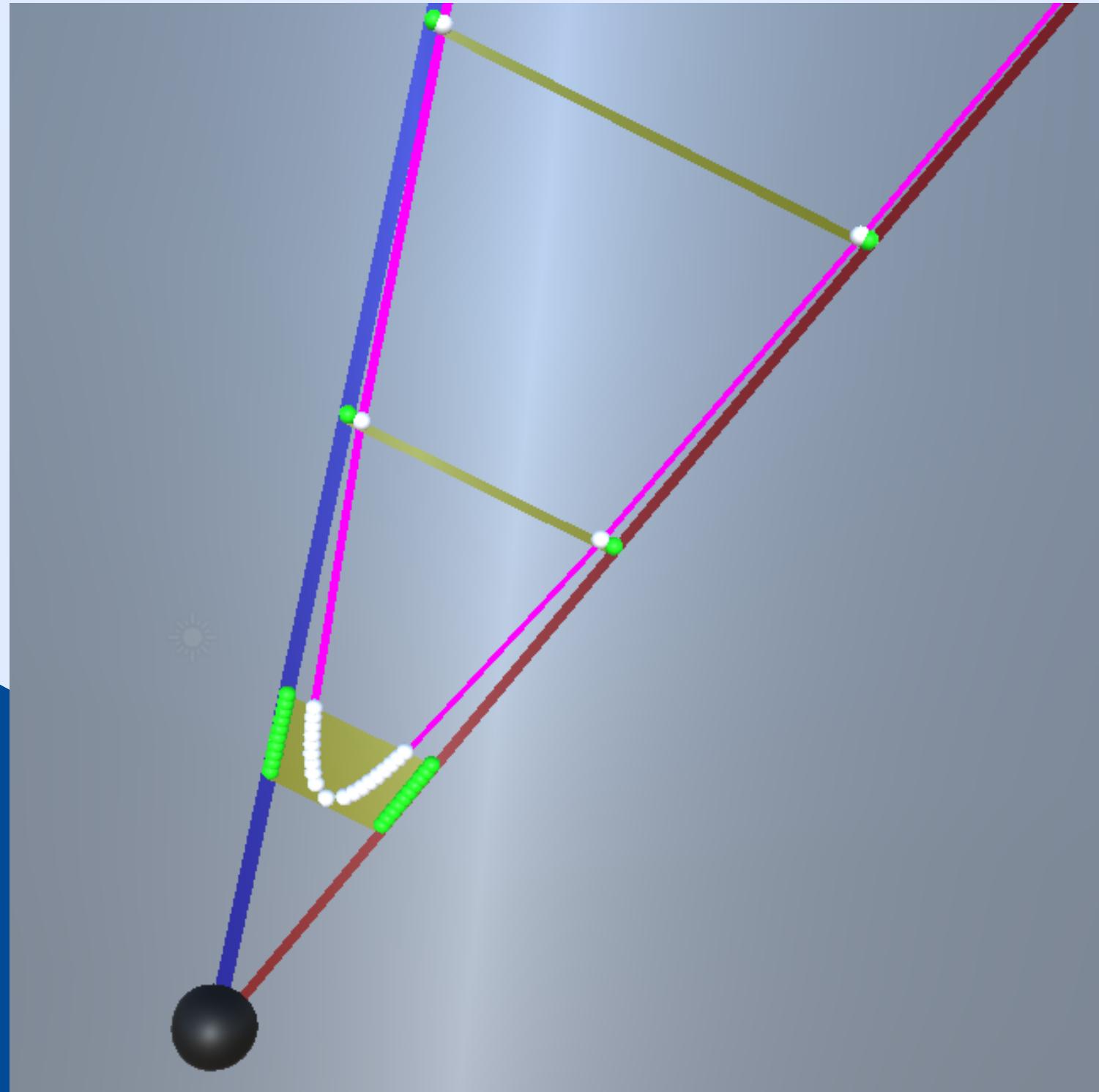


Unity

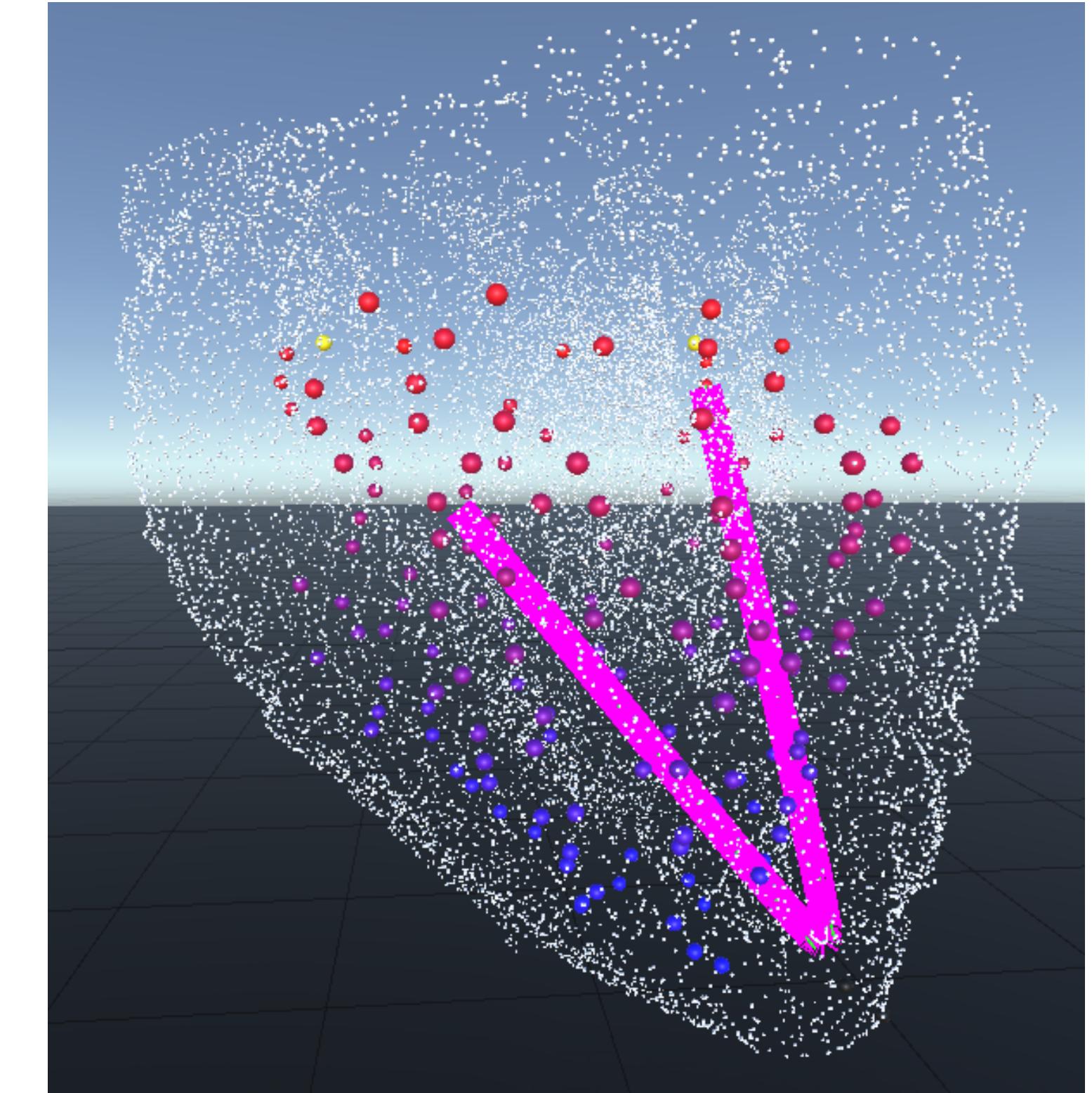
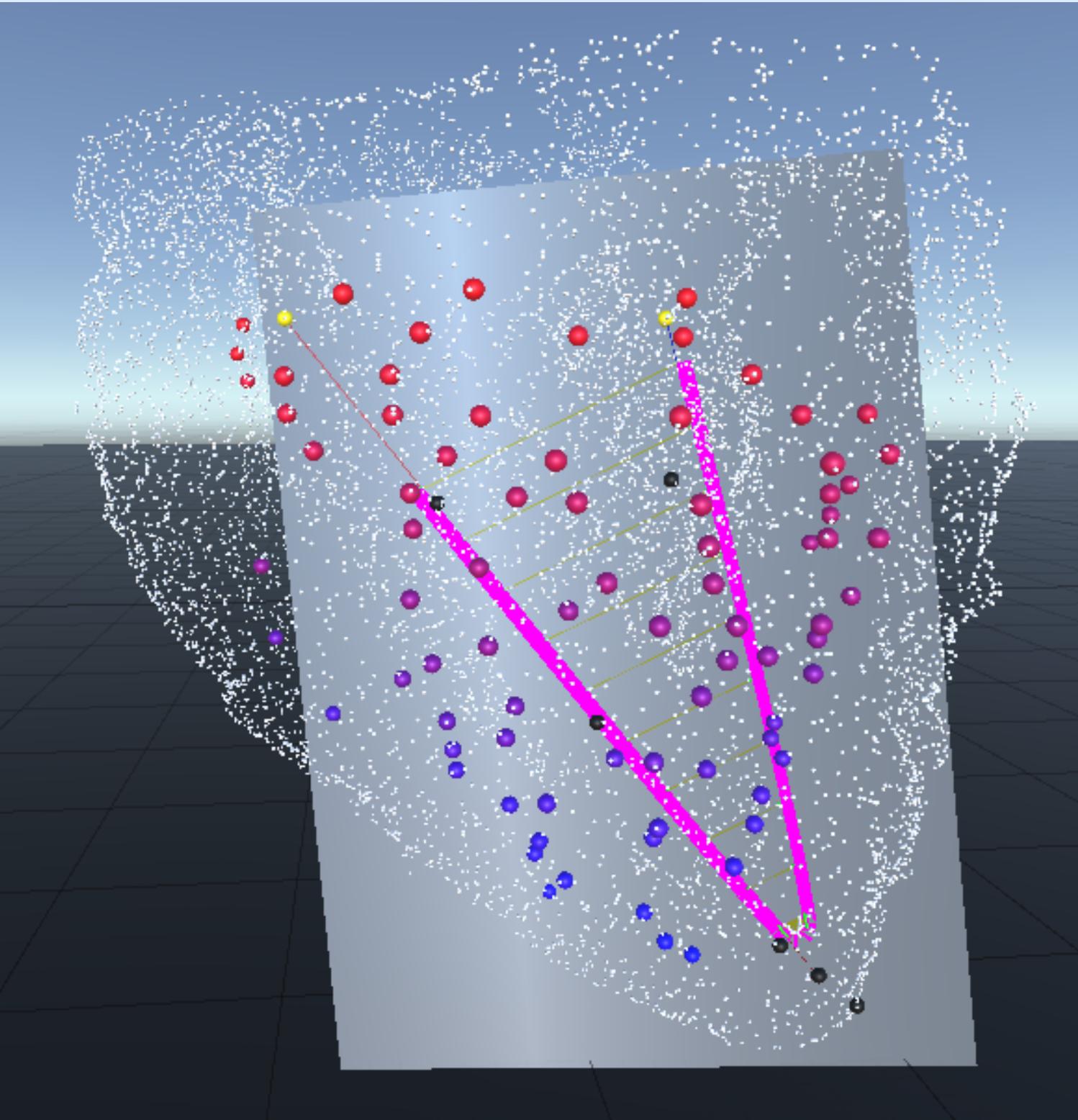


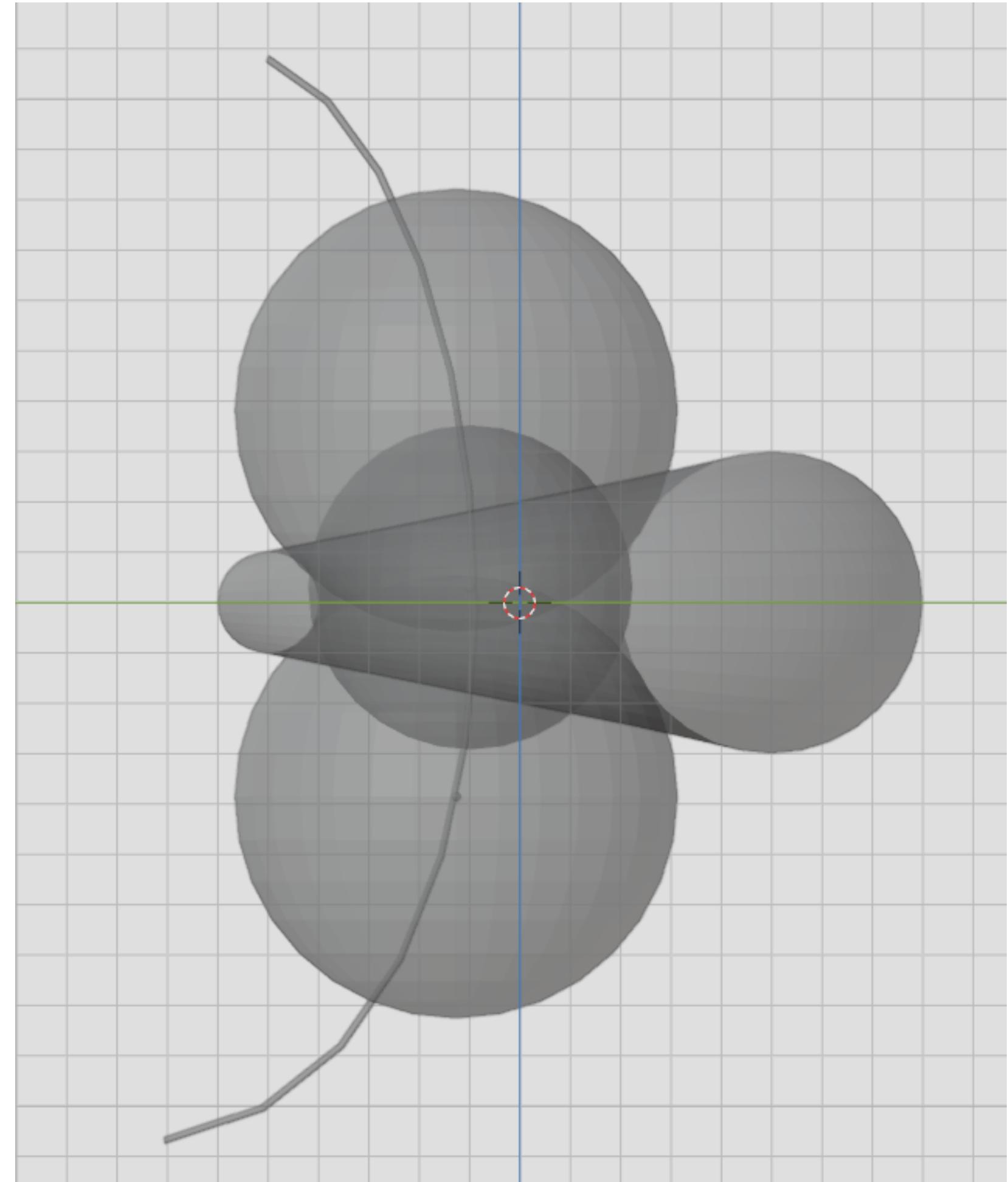
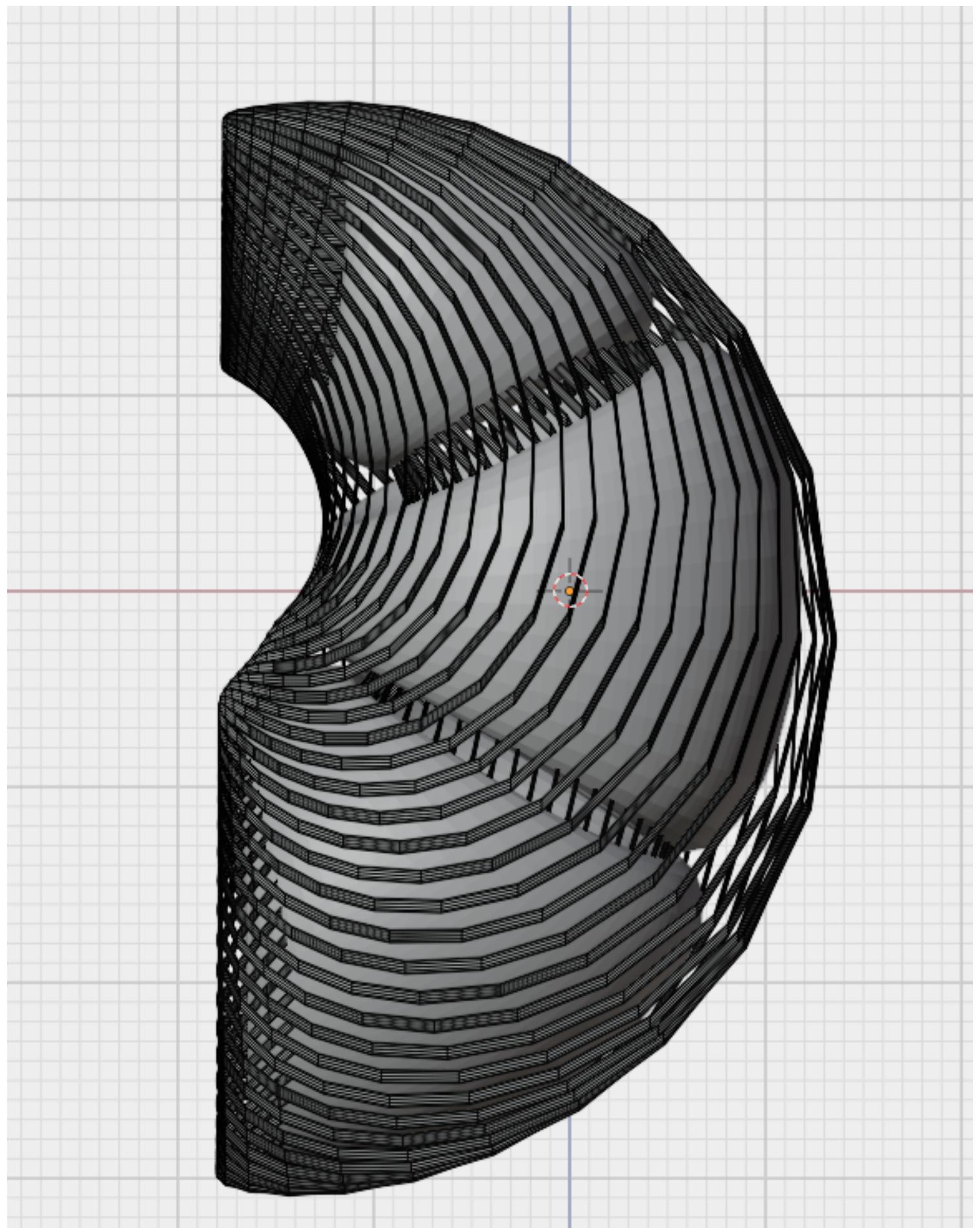
Résultats

Tracé de l'hyperbole :



Résultats





Conclusion

- **Réalisation du modèle demandé**
- **Utilisation des scripts à des fins de recherches**
- **Appliquer la programmation au monde de la médecine**
- **Collaborer avec des chercheurs**
- **Traduire, concrétiser un cahier des charges**
- **Environnement sain, développement des connaissances**